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DEPARTMENT OF POLITICAL AND SOCIAL SCIENCES

Education and Health Across Lives, Cohorts, and Countries

A Study of Cumulative (Dis)advantage in Germany, Sweden, and the United States

Liliya Leopold

Thesis submitted for assessment with a view to obtaining the degree of Doctor of Political and Social Sciences of the European University Institute

Florence, 04 May 2017

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Department of Political and Social Sciences - Doctoral Programme

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Abstract

According to the cumulative (dis)advantage hypothesis, social disparities in health increase over the life course. Evidence on this hypothesis is largely limited to the U.S. context. The present dissertation draws on recent theoretical and methodological advances to test the cumulative (dis)advantage hypothesis in two other contexts – Sweden and West Germany. Three empirical studies examine the core association between socioeconomic position and health (a) from a life-course perspective considering individual change, (b) from a cohort perspective considering socio-historical change, and (c) from a comparative perspective considering cross-national differences. The analyses are based on large-scale longitudinal data from the Swedish Level of Living Survey, the German Socio-economic Panel Study, the Health and Retirement Study, and the Survey of Health, Ageing and Retirement in Europe. The key analytical constructs are education as a measure of socioeconomic position and self-rated health, mobility limitations, and chronic conditions as measures of health.

The results show large differences within countries and between countries in the age patterns and cohort patterns of change in health inequality. In the U.S., educational gaps in health widen strongly over the life course, and this divergence intensifies across cohorts. In Sweden, health gaps are much smaller, widen only moderately with age, and remain stable across cohorts. In Germany, health gaps widen with age and across cohorts, but these patterns pertain only to men.

Taken together, these findings show that health inequality across lives and cohorts is mitigated in Western European welfare states, which target social inequality in health-related resources. In the U.S. context, which is characterized by a lack of social security, unequal access to health care, and large social disparities in quality of living, health inequality increases across lives and cohorts.

Publication record and declaration of the author’s contribution to the studies contained in this dissertation

(as of February, 2017)

Study I

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Sole authorship.

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Contribution of Liliya Leopold is approximately 80%. Co-authored with Thomas Leopold.

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Contents

Chapter I

Introduction

Health is one of the most important goods for individuals and societies. Being healthy is a precondition for achieving personal goals and fulfilling social roles. The societal benefits of improving population health and prolonging lives include not only reductions of health care expenditures, but also increases in productivity, labor supply, and economic growth (Bloom and Canning 2000).

Despite its immense value, large social groups still fail to maintain good health. Remarkably, this is not only the case in poor countries, but even in the most developed societies where the basic needs for being healthy – sufficient nutrition, medical supply, and adequate housing – have long been covered for the majority of the population (Fritzell et al. 2013; Marmot 2005; Mackenbach 2012). Moreover, substantial variation in the extent of social disparities in health exists not only between poor and rich countries, but also within the most advanced democracies (Smits and Monden 2009). In the U.S., for example, disparities between the least and the most affluent and educated people in mortality, physical functioning, and chronic conditions greatly exceed those in Western European countries. However, health disparities are substantial also in Western Europe. For instance, the gap between lower and higher educated people in disability-free life expectancy amounts to eight years; the probability of being in good self-rated health amounts to about 30 percentage points (Hu et al. 2016; Mäki 2013; Mackenbach 2008). Although the most recent studies report positive trends of declining social inequality in mortality, substantial disparities in health and mortality status persist in Europe (Mackenbach et al. 2016; Mackenbach et al. 2014) and in the U.S. (Currie and Schwandt 2016, Hu et al. 2016).

Despite the advances in knowledge about the magnitude and trends in social disparities in health, our understanding of this phenomenon within and between countries in still limited. In particular, we know little about how social disparities in health change over the life course, how life-course patterns change across cohorts, and how these interrelated processes vary between countries. This limitation is important, given that (a) social disparities in health emerge as a life-course process, (b) these life-course patterns are influenced by social change that is captured primarily by cohort effects, and (c) both life-course and cohort-specific dynamics are embedded into institutional settings within national contexts, producing international variation in social disparities in health.

Health inequality across the life course

Physical health follows an age trajectory that is shaped by biological factors. In early adulthood, people usually maintain good health although biological risks accumulate. In middle adulthood, health starts to deteriorate. This decline accelerates in later adulthood, resulting in functional limitations, disability, and mortality (Blane et al. 2016; Bartly 2004; Hayward and Sheehan 2016; Ferraro 2016). Social disparities in health emerge from differences between social groups in these trajectories. The biological forces underlying age trajectories of physical health are often disregarded in studies of health inequality. A case in point are studies which average differences in health across large age spans (Hayward and Sheehan 2016). This approach cannot capture the life-course process of emergence and change in social disparities in health.

This limitation is important, given that life-course profiles of health inequality convey information that is crucial to evaluate the extent of, and mechanisms behind, health inequality (Ferraro 2016). At what age do differences in health emerge? How fast do they grow? Is this growth reversible? What is the role of the welfare state in this process? For example, average disparities might be similar in two countries, but the mechanisms producing them, and the associated life-course trajectories of health, might be different. In some contexts, socioeconomic disparities in health might emerge early in life, increase moderately throughout adulthood, and remain stable in older age. In others, these disparities may increase strongly during adulthood and decrease in older age when the surviving population is reduced to robust individuals. Although these scenarios differ sharply regarding the extent of health inequality and the forces shaping these inequalities, these differences would remain largely invisible to a cross-sectional analyst who looks only at averages across all ages (Hayward and Sheehan 2016).

Health inequality across cohorts

Life-course trajectories of health are shaped by the conditions surrounding different birth cohorts (Elder et al. 2003). Cohort effects capture health differences between individuals that arise from their "unique location in the stream of history" (Ryder 1965, p. 844), which exposes people of similar age to the same socio-historical conditions. The crucial mechanism behind cohort effects is that individuals experience social change differently, depending on their life stage (Elder 1986, 1987; Elder et al. 2003;). For example, those who were in school age during the educational expansion of the 1950s were able to improve their educational opportunities, in contrast to those who had already graduated in the 1940s (Shavit and Blossfeld 1993; Blossfeld et al. 2016).

Similarly, those who were born only few years before the baby-boom cohorts had much higher economic returns to education (Blossfeld 1986, 1987; Bookmann and Steiner 2006).

Moreover, the magnitude of the effects of common health shocks such as epidemics, wars or economic crises strongly depend on the life stage at which individuals are exposed to them (Hayward and Sheehan 2016). These effects are most directly captured by cohort differences (Hayward and Sheehan 2016; Johnson et al. 2016). For instance, the most recent economic crisis had stronger negative effects on more recent cohorts who are affected at labor market entry or early in their careers, much in contrast to those who are already advanced in their career or even retired (Blossfeld et al. 2005, 2007; Burgard and Karlousova 2015). Another example is the current Zika epidemic, which has much stronger negative effects in the prenatal stage (WHO 2016).

Considering cohort effects in research on disparities in health is essential, given that these effects are often stratified along socioeconomic lines. For example, the higher educated young adults suffer less from the economic crises than their lower educated counterparts. Similarly, children of higher educated parents are more likely to avoid dangerous viruses than children of lower educated parents. Life course trajectories of socioeconomic disparities in health, thus, are profoundly shaped by socio-historical change captured by cohort effects.

Yet, this insight is still not sufficiently recognized in empirical research. In a recent review of life-course studies on health, Hayward and Sheehan (2016: 356) conclude that "life course research on adult health must attend more explicitly to the historical context to better understand trends and differences in the life course pathways leading to adult health problems. Dramatic changes have occurred across current birth cohorts represented in the adult population in their prenatal, childhood and adult exposures, yet these changes are rarely central in life course studies of health."

Health inequality across countries

The empirical finding that health inequality over the life course is responsive to social change reflects the importance of contextual influences that have been ignored in much of previous research (Hayward and Sheehan 2016). In particular, changes of social disparities in health over the life course and across cohorts are embedded into the institutional context that varies markedly between countries (Mayer 2015). Different countries provide more or less favorable institutional conditions for social disparities in health to unfold and to change with age. Among such institutional features are educational systems that might be more or less inclusive or stratifying, employment policies that are more or less protective in terms of unemployment risk and exposure to adverse working conditions, public support after negative life events that is more or less generous, and social policy interventions that are more or less effective in targeting risky health behaviors (Bambra and Beckfield 2012; Beckfield et al. 2015; Herd 2016).

Countries also differ in the degree and direction of social change and in the effects of common shocks on social disparities in health across cohorts (Hayward and Sheehan 2016). For instance, while in some countries educational expansion was dramatic and led to a strong devaluation of higher education (Bol 2015), societies with more regulated labor markets dampened the degree of educational expansion and coordinated it better with the labor market (e.g., Germany). Still others experienced an increase in economic returns to education (e.g., the U.S.) (Blossfeld et al. 2016). In a similar vein, the most recent economic crisis affected young cohorts more or less strongly in different countries. While Spain is at risk to "lose" a whole generation, Germany has experienced a decline of unemployment and substantial economic growth despite the crisis (Burgard and Karlousova 2015). These examples demonstrate that it is important to consider the influences of national context on life-course and cohort patterns of social disparities in health. Yet, as Herd

(2016: 661) has concluded in her recent review of the literature on social policy and life-course health "social welfare policies, or the state more broadly, have not been incorporated theoretically or empirically into life course research on health disparities."

Aims of the present dissertation

In sum, understanding health inequalities requires answering the following questions: Do social disparities in health increase, remain stable or decrease with age? How does the linkage between socioeconomic position and health change across lives? How are life-course patterns affected by social change? How do countries differ in these interrelated processes?

Current research offers only limited insight into these questions. In particular, internationally comparative research on health inequalities and their development over time does not commonly investigate this phenomenon from a life-course and cross-cohort perspective (Herd 2016). Based on data from single or repeated cross-sections, these studies did not trace the life-course trajectories of social disparities in health and cross-cohort differences in these trajectories.

Conversely, research on life-course and cross-cohort change of social disparities in health lacks an internationally comparative perspective (Herd 2016). These studies use large-scale longitudinal data or examine age and cohort effects on health, but their evidence is largely limited to one national context – namely the United States. This is an important omission, given that the inclusion of other country contexts offers novel insight into key factors such as the role of educational systems in the creation of health inequality or the role of social policy in targeting this inequality.

The aim of the present dissertation is to fill these gaps of knowledge. Drawing on theoretical and methodological advances from U.S. studies, I extend the evidence to two further national contexts – Sweden and West Germany. In doing so, I consider individual and contextual influences on the core association between socioeconomic position and health, viewing it (a) from a life course perspective considering individual age-related change, (b) from a cohort perspective considering socio-historical change, and (c) from a comparative perspective considering cross-national differences.

In the following, I review major theoretical and methodological developments as well as empirical results on changing health inequality and discuss the limitations of previous research in more detail. Based on these considerations, I will then explain how my dissertation contributes to this field of research.

Two decades of research on social disparities in health across lives and cohorts

The Cumulative (Dis)advantage Hypothesis

Research on the origins and life-course dynamics of social disparities in health has been guided by the cumulative (dis)advantage approach (DiPrete and Eirich 2006; Dannefer 1987, 2003; O'Rand 1994; Ferraro et al. 2009; Ferraro and Shippee 2009). It draws on several propositions of classical life-course theory, namely that individual life courses are embedded in socio-historical contexts surrounding each birth cohort, and shaped by institutions, linked lives, individual agency, multiple trajectories, and turning points in these trajectories (Elder 1985, 1998, 2003).

Combining life course theory with Merton’s work on inequality in scientific carriers, the cumulative (dis)advantage approach describes a process by which initial differences in resources increase with age (Diprete and Eirich 2006; Ferraro et al. 2009; O’Rand 1994; Merton 1968). Early advantages and disadvantages of social background, education and labor market placement structure the distribution of resources as well as the onset and duration of exposure to environmental and social risks. Differences in the prevalence and timing as well as in the direction and magnitude of the effects of influential events, transitions and exposures lead to an increase of inequality in life trajectories between socioeconomic groups (Ferraro et al. 2009; Ferraro and Shippee 2009).

With regard to health, the cumulative (dis)advantage hypothesis states that advantages (e.g., material and psychosocial resources) and disadvantages (e.g., risky health behaviors, adverse working and living conditions, experience of disruptive life events) are divided along socioeconomic lines. These differences emerge early in life and accumulate over the life course (Hayward and Gorman 2004; O'Rand 2005; Ross and Wu 1996; Willson et al. 2007). The main prediction to follow from these life-course mechanisms is that higher socioeconomic groups are better able to maintain good health, whereas lower socioeconomic groups experience steeper health declines. As a result, social disparities in health are expected to widen with age.

In previous studies on health inequality, a widening gap between health trajectories with age has been commonly interpreted as evidence for the cumulative (dis)advantage hypothesis (Herd 2006; Kim 2008; Kim and Durden 2008; Lynch 2003; Mirowsky and Ross 2008; Ross and Wu 1996; Willson et al. 2007). In keeping with this literature, the current dissertation also examines the cumulative (dis)advantage hypothesis on the basis of aggregate-level health trajectories. It is important to note, however, that an aggregate-level pattern of widening health gaps between educational groups does not necessarily emerge from processes of accumulation at the individual level (Dupre 2007). Conversely, an absence of this pattern does not necessarily indicate the absence of such processes at the individual level. In light of these complications, caution is warranted about conclusions regarding the mechanisms underlying aggregate-level health trajectories (Allison et al. 1982; Bask and Bask 2015).

Testing the cumulative (dis)advantage hypothesis

Measures of socioeconomic position and health

In tests of the cumulative (dis)advantage hypothesis, education is considered the most suitable measure to capture the cumulative effects of socioeconomic position over the life course. The reasons for this are threefold. First, education is attained early in life and typically precedes other major indicators of socioeconomic position, such as occupation and income. Second, education is a measure that is available for the entire adult population. When using occupational class or labor market income, non-employed persons are excluded from the analysis. In many cases, these persons might be among the most disadvantaged. Third, education remains largely stable after young adulthood. This is an advantage of education as a measure of life-long socioeconomic position. Income, in contrast, increases until late adulthood, but decreases after retirement (Ross and Wu 1996). Although a number of studies have complemented education with other indicators of socioeconomic position, such as income (Kim and Durden 2007), wealth (Willson et al. 2007) or more complex measures of socioeconomic status (House 1994, Pudrovska 2014), educational still constitutes the core measure in studies on the cumulative (dis)advantage hypothesis.

The most common health measure in these studies was self-rated health. This measure is sensitive to changes in morbidity and functional limitations over the major stages of the life course (Idler and Benyamini 1997). This is an important benefit compared to measures of chronic conditions, such as hypertension or diabetes, which typically emerge in midlife, or mortality, which is most commonly a later-life event. Measures of self-rated health, in contrast, reveal health differences already early in life.

A limitation is that self-rated health is less sensitive to steepening of health declines later in life. In tests of the cumulative (dis)advantage hypothesis, this may bias the results, suggesting a declining effect of education on health in older age. To overcome this shortcoming, studies have complemented the analysis on self-rated health with health measures that are more sensitive to health changes in later life, such as chronic conditions (Dupre 2007), physical limitations such as SF-12, ADL or IADL (Kim 2008; Xu et al. 2015), and mortality (Pudrovska 2014).

Tests of the cumulative (dis)advantage hypothesis typically focus on change in absolute health gaps between socioeconomic groups rather than on relative measures such as Odds Ratios (OR). The reason for this is that absolute differences in health trajectories fit more closely with the process described by the cumulative (dis)advantage hypothesis. Consider the following example. At the age of 30, one out of 100 higher educated people and three out of 100 lower educated people report poor health. This difference amounts to 2 percentage-points in absolute terms and to 3.06 (OR) in relative terms.[1] Ten years later, ten higher educated people and twenty lower educated people report poor health. This difference amounts to 10 percentage-points in absolute terms and 2.25 (OR) in relative terms. In line with the pattern postulated by the cumulative (dis)advantage hypothesis, health has declined faster among lower educated people, resulting in an 8-percentage-points increase of educational differences in the probability of being in poor health. In terms of Odds Ratios, however, the difference has declined. Although Odds Ratios and other measures for relative differences are commonly used in epidemiology and research on social inequality in health,

[1] OR (at age 30) = 3x99/1x97=297/97= 3.06. At the age of 30, lower educated have a three times larger chance to report poor health.

they are not well-suited to capture the process described by the cumulative (dis)advantage hypothesis.

Modelling life-course trajectories of health inequality

The cumulative (dis)advantage hypothesis has long been contested both on theoretical and empirical grounds. Although it was supported in pioneering studies of health inequality over the life course (e.g., Ross and Wu 1996), many findings were inconsistent with the expected divergence of health trajectories between socioeconomic groups. Instead, patterns of continuity or even convergence were found (e.g., Clark and Maddox 1992; House et al. 1994). This conflicting evidence fueled a debate in the U.S. literature on health inequality over the life course. Analysts who reported persistent or converging health gaps advanced the idea of "age as leveler" as a competing hypothesis to cumulative (dis)advantage.

The "age as leveler" hypothesis stressed the importance of social policy and selection effects as counter-balancing factors offsetting or even prevailing over the forces of accumulation. Social policy arguments concentrated on institutional interventions such as Medicare, providing more equal access to health care, or Social Security, alleviating economic inequality among older adults (Dannefer 1987; Herd 2016). The selection argument, in contrast, attributed the decline of educational health differences in older age to selective mortality and selective participation in surveys: Because of elevated rates of mortality and health decline among the lower educated, only the more robust continued to be observed in surveys, whereas the group of highly educated individuals remained largely unaffected by selective attrition (Kitagawa and Hauser 1973; Wilkinson 1986; Hoffmann 2011).

More recent studies on the selection argument have reconciled observed patterns of convergence with the cumulative (dis)advantage hypothesis (Beckett 2000; Lynch 2003; Willson et al. 2007). This research has concluded that differential mortality coupled with selective attrition among the lower educated compresses estimated differences in health between educational groups (Noymer 2001). Consequently, the inconsistent empirical picture resulted mainly from the use of cross-sectional or short-term (two-wave) longitudinal designs. In such investigations, older respondents of lower socioeconomic groups constitute a highly selective group of robust individuals. Importantly, these studies have suppressed potentially diverging health trajectories among younger and middle-aged people because the cross-sectional nature of their data precluded them from separating age and cohort effects.

The problem of confounding age and cohort, however, is not only a methodological issue. More importantly, such designs disregard the fact that lives of individuals from different birth cohorts unfold in different socio-historical contexts. This gives rise to actual – rather than selection-driven – cohort differences in educational health trajectories. Reviewing demographic research from the past decades, Lynch (2003) has shown that health trajectories of educational groups vary markedly across cohorts.

The key implication of these considerations is that an adequate test of the cumulative (dis)advantage hypothesis must consider cohort effects both theoretically and empirically. In statistical models, this is typically done by including interactions between socioeconomic position, age, and cohort: (1) interactions between age and cohort, as individuals from more recent cohorts might show different levels of average health; (2) interactions between socioeconomic position and cohort, as the effect of socioeconomic position on health might have changed across cohorts; (3) threefold interactions between socioeconomic position, age, and cohort, as the shape of socioeconomic health trajectories over the life course might also change across cohorts. Disregarding these interactions will bias results on the cumulative (dis)advantage hypothesis if the distribution of health-related advantages and disadvantages between socioeconomic groups has changed across cohorts. If divergence increases in recent cohorts, for example, cross-sectional estimations will deliver the opposite results, indicating convergence with age (Lynch 2003). Moreover, designs that disregard these interactions implicitly assume identical health trajectories in every cohort. These designs implicitly invoke a laboratory setting in which social conditions remain stable over time.

Previous research

Over the past two decades, studies have provided extensive evidence on cumulative (dis)advantage in socioeconomic disparities in health. In Table 1, I summarize the results of empirical studies that have (a) examined how socioeconomic disparities in health or mortality change with age, (b) used representative population data, and (c) applied the state-of-the-art longitudinal designs that allowed the authors to disentangle age and cohort effects.[2]

As Table 1 demonstrates, studies from the U.S. that fulfill the criteria for an adequate test of the cumulative (dis)advantage hypothesis have provided strong support for this hypothesis.[3] These

[2] My search method included 1) a key-word search in Google Scholar, and 2) a citation search. I used the key words "cumulative advantage", "health", "age", "life course", "cohort", "education", "SES" and different combinations of these key words. Through this method, I identified the most relevant articles. In a second step, I identified articles that cited the articles identified in the first step. Here I started with pioneering studies (House et al. 1990, 1994; Ross and Wu 1996) and searched in all articles that cited these studies. Then I searched in all articles citing the studies that cited the initial set of studies, and so on.

[3] Table 1 does not include influential studies from the U.S. that have contributed to the development of the current state of the art, but did not yet applied it in their analysis (House et al. 1990, 1994; Ross and Wu 1996, Clark and Maddox 1992). It also does not include studies that did not disentangle age and cohort effects (e.g., Cullati 2015; Herd 2006; Knesebeck 2005; Prus 2007; Schöllgen et al. 2010; Schmidt et al. 2013; Schurer et al. 2014; Xu et al. 2015) as well as studies that did not provide country-specific evidence, averaging across a number of countries (Leopold and Engelhardt 2013; Dellaruelle 2015).

studies showed an increase of socioeconomic gaps in self-rated health, functional limitations, chronic conditions, and mortality across all major stages of adulthood (Dupre 2007; Kim 2008; Kim and Durden 2007). Moreover, they have pointed to a greater rate of divergence in more recent cohorts, compared to older cohorts (Lynch 2003; Mirowsky and Ross 2008; Kim 2008; Willson et al. 2007). Although these findings offer compelling evidence for the context-specific nature of cumulative (dis)advantage, an internationally comparative perspective on social disparities in health across lives and cohorts is still limited. About two thirds of current state-of the art evidence comes from the U.S.

This limitation is important for three reasons. First, the evidence on life-course trajectories of socioeconomic disparities in health found in the U.S. cannot be generalized to other societies. Since decades, the United States is regarded as the most unequal among developed societies (OECD 2016). With its lack of social security, highly unequal access to health care, large social disparities in quality of living and economic returns to education, this context provides particularly favorable conditions for the forces of cumulative (dis)advantage to unfold.

This contrasts with most of Western European and in particular with Scandinavian countries, which target social equality in health-related resources. If these policies are effective, they might slow down or even offset the process of cumulative (dis)advantage. In support of this idea, van Kippersluis and colleagues (2009) found that in the Netherlands educational, occupational, and income differences in self-rated health and disability increased only until the age of 55 and remained stable or even converged thereafter. Their additional analysis showed that these patterns were unaffected by cohort differences or selection due to mortality.

TABLE 1: REVIEW OF THE EMPIRICAL EVIDENCE ON THE CUMULATIVE (DIS)ADVANTAGE HYPOTHESIS

Country	Author	Year	Data	Period	Age range	Measure(s) of SES	Measure(s) of Health	Results	
								Age patterns	Cohort patterns
US	Lynch	2003	NHEFS	1979-1992	24-77	Education	Self-rated health	Divergence across the entire age range	Increase of divergence
US	House et al.	2005	ACL	1986-2002	25-99	Education	Functional limitations	Divergence in recent cohorts until age 75; Convergence in the earliest cohort (1902-16)	Increase of divergence
US	Willson et al.	2007	PSID	1984-2001	26-92	Education Income Wealth	Self-rated health	Slow divergence in more recent cohorts; Continuity in the earliest cohorts (1909-18)	Increase of divergence
US	Dupre	2007	NHANES	1971-1992	25-95	Education	Onset and duration of chronic diseases	Divergence in the age at onset and duration of diseases	Increase of divergence
US	Goesling	2007	NHIS	1982-2004	30-70+	Education	Self-rated health	Divergence across the entire age range	Increase of divergence
US	Kim and Durden	2007	ACL	1986-1994	25-97	Education Income	Physical impairment, Depression	Divergence of educational differences across the entire age range	Increase of divergence
US	Dupre	2008	NHANES I NHEFS	1971-1992		Education	Incidence and survival duration of hypertension and heart attack	Divergence of educational differences in rates of disease incidence and survival	Cohort effects are accounted for but the results are not reported
US	Kim	2008	ACL	1986-1994	25-97	Education	Functional limitations	Divergence across the entire age range	Increase of divergence
US	Mirowsky and Ross	2008	ASOC	1995-2001	21-93	Education	Self-rated health	Divergence until the age of 75; Continuity from age 75 onwards	Increase of divergence

Continued on next page

Table 1 continued

US	Mirowsky and Ross	2010	ASOC	1995-2001	18-101	Education	Physical impairment	Divergence across the entire age range	Increase of divergence
US	Ailshire and House	2012	ACL	1986-2002	25-84	Education	BMI	Divergence across the entire age range	Increase of divergence
UK	Sacker et al.	2005	BCHP	1991-2001	21-69	Occupational class	Self-rated health	Divergence across the entire age range	Cohort effects controlled but not reported
China	Chen et al.	2010	CHNS	1991-2004	21-101	Education Income	Self-rated health	Divergence across the entire age range	Decrease of divergence
Netherlands	van Kippersluis et al.	2010	HIS	1983-2000	16-80	Education Income Occupation	Self-rated health Disability	Divergence until approx. the age 55; Continuity between educational groups from age 55 onwards Convergence between income groups and occupational groups from 55 onwards	Small and non-systematic differences
Australia	Schurer et al.	2014	HILDA	2001-2011	20-85	Education Occupation Income	Bodily pain	Divergence across the entire age range	No clear pattern
Mexico	Torres et al.	2016	MHAS	2001-2012	50-100	Childhood SES Occupation Education Wealth	Self-rated health Functional limitations	Continuity across the entire age range	Increase of gaps across cohorts

Continued on the next page

Table 1 continued

UK, DE, DK, US	Sacker et al.	2011	PSID BHPS GSOEP ECHP	1995-2001	25-65	Grouping into advantaged vs. disadvantaged[#]	Self-rated health	Divergence in each country. Strongest in the U.S. followed by UK, DE and DK	Cohort effects controlled but not reported

11 EU countries	van Kippersluis et al.	2009	ECHP	1994-2001	18-85	Income Gini	Self-rated health	Divergence with age in DE,UK,NL,FR Mixed evidence in BE,DK,GR,IR,IT,PT,SP	No systematic change across cohorts
Russia, Poland and Czechia	Hu et al.	2016	HAPIEE	2002-2012	45-69	Education Income	SF-12 physical functioning	Divergence across the entire age range in each country. Smaller in Czechia than in Poland and Russia	No cohort pattern in Czech Republic Increase of divergence in Russia and Poland

Note: Sacker et al. 2011 based on factor analysis defining advantaged as male, majority status, cohabiting with a partner, educated to tertiary level, employed in a non-routine occupation, and with an adjusted household income above the within-country median; Disadvantaged: female, minority status, no longer living with a partner, lower secondary education, unemployed, in a routine occupational class, and an income below the median adjusted household income.

Second, similar to the findings on age trajectories, U.S. findings on cross-cohort differences in these trajectories cannot be generalized to other developed societies. Social change driving cohort effects on the cumulative (dis)advantage process in the U.S. differs strongly from other developed countries. Many societies have experienced a decline rather than an increase in economic returns to education, no change in inequality in health behaviors, and less change in the composition of educational groups (Dellaruelle et al. 2015). These differences can be expected to result in different cohort patterns. In support of these considerations, Table 1 shows that cross-cohort patterns outside the U.S. differ substantially from those found in the U.S. context. In China, the opposite of pattern was found – a decline of divergence in socioeconomic differences with age (Chen et al. 2010). Other countries did not show a clear pattern (van Kippersluis et al. 2010).

Third, the focus on only one national context limits the analysis of variation in institutional settings and social change, both of which are fundamental to the life course perspective. This perspective emphasizes that socio-historical conditions and structural context influence the timing and effects of important transitions or turning points that shape individual trajectories in multiple domains of life (Dannefer 2003; Elder 1985; O'Rand 1994; George 1996; Elder et al. 2003). Inattention to such variation leads to an implicit assumption that institutional settings do not shape individual health trajectories (Corna 2013; Hunt 2002; Siddiqi and Hertzman 2007). The results from the United States on cross-cohort trends contradict this assumption and point to the importance of change in social conditions for life-course trajectories in socioeconomic health disparities. Cross-cohort changes within the United States are, however, much smaller than cross-national differences between the United States and other countries when considering health-relevant policies shaping social disparities in health, such as social security, tax policies, employment protection, maternity or parental leaves, childcare, unemployment benefits, pension structures, and access to health care

(Avendano and Kawachi 2014; Herd 2016; Hayward and Sheehan 2016). Consequently, a comparative view can shed more light on the importance of context for health inequality over the life course.

The few studies that have directly compared countries have provided initial insights into such variation. Van Kippersluis and colleagues (2009) compared 11 European countries and supported the cumulative (dis)advantage hypothesis in Germany, France, the UK, and among women in the Netherlands. Other countries showed continuous patterns of health inequality with age. Across cohorts the patterns were even less consistent. Similarly, one of the most recent studies on socioeconomic disparities in health across age and cohorts in Eastern Europe has shown cross-country differences between Czechia, Russia and Poland in the size and degree of change in educational gaps in physical functioning (Hu et al. 2016). This study reported findings consistent with the cumulative (dis)advantage hypothesis in each country, but this patterns was more pronounced and increasing across cohorts in Russia and Poland. Finally, Sacker and colleagues (2009) have compared the U.S., the U.K., Germany, and Denmark. They have shown that cumulative (dis)advantage applied in each of the countries, but the degree to which it applied differed. The strongest divergence was found in the U.S., followed by the U.K., Denmark, and Germany.

The major merit of studies outside the U.S. is that they pointed to heterogeneity in the life-course and cross-cohort patterns of social disparities in health between various societies. Despite this merit, these studies are limited both theoretically and empirically. At the theoretical level, these studies hardly provide any reasons for their selection of countries or guidance on what to expect in different national contexts. The selection of country contexts was mainly driven by pragmatic reasons, such as availability of data or missing evidence from a particular country, but not by a substantive rationale on theoretically important questions. Why is it interesting to examine a certain national context regarding social disparities in health across lives and cohorts? Which institutional features distinctively shape social disparities in health in a certain national context? Did these features change over time, potentially producing distinct cross-cohort patterns?

A discussion of context specific features, instead, was provided mainly in hindsight. Although the findings of these studies suggest that institutional context is important in shaping social disparities in health across lives and cohorts, we do not know much about the driving forces behind such country differences. Are these country differences rooted in the structure of educational system and its connection to the labor market, in redistribution policies, in preventive interventions targeting smoking and heavy drinking, or in the quality and access to health care? An assessment of such factors requires a theoretical framework, which has not been offered in previous studies (Beckfield et al. 2013).

At the empirical level, the limitations of previous comparative research are threefold. First, we lack directly comparative evidence across countries. The existing single case studies compare their results to previous evidence from the U.S., but differences in samples, measures of social position, measures of health, and statistical modelling preclude a direct comparison. For instance, Chen et al. conclude that socioeconomic differences in health diverge much less in China than in the U.S. However, unlike most U.S. studies, Chen et al. control for possible explanatory factors in each of their models. As a result, they compare educational differences in health net of differences in income and health behaviors with educational differences found in the U.S. studies that did not control for such factors. Van Kippersluis and colleagues (2010) conclude that they found a pattern that contradicts the U.S. evidence using repeated cross-sectional data. Most evidence from the U.S., however, is based on panel data following the same individuals over time. Differences between the evidence from the Netherlands and from the United States might therefore result from differences in statistical designs. Finally, even the only study that compares socioeconomic disparities in health over the life course in the U.S.

and in three European countries does not use harmonized data (Sacker et al. 2011). Although broadly comparable, the data in each country differ regarding observation period, number of waves, observation points at which health was measured, and in measures of key variables such as education, income, and occupation. It remains unclear whether different findings of these studies reflect actual cross-country differences or differences in data, models, and measures.

Second, the only study that used directly comparable harmonized data across 11 European countries (van Kippersluis et al. 2009) was based on a short observation window of only six years. Their findings of continuity in age patterns in most of the countries and mixed cross-cohort patterns might be due to the short observation window. For instance, it might be that in these countries, disparities are not stable with age, but change only slowly. In this case, evidence for cumulative (dis)advantage could be found only if the sample is observed longer (Johnson et al. 2016). The cross-cohort evidence of this study is limited as well, because the short observation window allowed only for minimal age-cohort overlaps.

Third, even though an increasing number of studies outside the U.S. context has provided initial insights into international variation in socioeconomic disparities in health across lives and cohorts, only few countries are covered and in the most countries the evidence is limited to only one study. This is an important limitation, especially when compared to the evidence from the U.S. where more than 20 studies have examined the cumulative (dis)advantage process in social disparities in health using a variety of datasets, measures of social position and health, and covering various age groups and cohorts. Outside the U.S., even in countries where suitable data are available, the evidence is either missing entirely or is limited to a single study.

Overview of the contributions of the present dissertation

In view of the limitations outlined above, the present dissertation aims at providing internationally comparative studies on socioeconomic disparities in health across lives and cohorts that are (a) theoretically informed, (b) allow to disentangle age and cohort effects on the basis of extensive observation windows, and (c) cover contexts that were not or not sufficiently examined in previous research.

My overarching strategy is to build on theoretical and methodological advances of U.S. studies in order to analyze whether the social forces that have shaped health trajectories within this country apply to a lesser, similar, or even greater extent in two other contexts – Sweden and West Germany. Extant research suggests marked differences for these contexts compared with the U.S. If this contextual variation is influential, social disparities across lives and cohorts will take different shapes.

Moreover, the U.S., Sweden and West Germany represent pertinent contexts of previous comparative research. These three contexts represent typical welfare regimes in one of the most influential classifications by Esping-Andersen. In his typology, the U.S. stands for the liberal, West Germany for the conservative, and Sweden for the social democratic regime (Esping-Andersen 1999). In research on education and transitions into the labor market, West Germany is a prime example for a strongly stratified and standardized vocational educational system coupled with a highly credentialist labor market (Shavit and Müller 1998; Blossfeld and Mayer 1997). The U.S. is a prime example of the opposite – one of the least stratified and standardized educational systems that is only loosely connected to the labor market. Sweden is often put in between with its educational system that is less stratified – and weakly connected to the labor market, similar to the U.S., but highly standardized, similar to Germany (Pfeffer 2008).

Finally, comparative life course research has often focused on these three countries, as they provide meaningful contrasts regarding the structure of the life course, career trajectories, family processes, and important life course transitions such as leaving home, completing education and training, labor market entry, and retirement (Mayer 2015; DiPrete 2002; DiPrete et al. 1997). West German life courses are typically classified as strongly structured and highly stable, whereas the life course in the U.S. is regarded as volatile and less structured. Sweden, again, can be placed between these poles (Bertaux and Kohli 1984; Mayer 2005). Regarding the role of the welfare state in preventing life-course risks and managing adverse consequences if risks materialize, Diewald (2016: p. 678) classifies Sweden as a prototypical welfare state with a low level of prevention against risks, but an effective management of adverse consequences of risks. For example, Sweden does not discourage divorce by providing financial incentives to staying married. In case of divorce, however, social policy compensate for negative economic effects. This is achieved, for instance, by encouraging female employment and providing sufficient possibilities for childcare. Germany, in contrast, is classified as a country aiming mainly at risk prevention, but focusing less on managing adversity. The U.S. are a prototype of a welfare state characterized by high risks and low levels of compensation for the resulting adversity (DiPrete 2002; Diewald 2016; Mayer 2005).

Exploiting these theoretically meaningful differences, a large literature has examined these three countries regarding key institutional characteristics and social inequality in multiple domains of life, including educational opportunity, occupational mobility, family dynamics, unemployment risks, and consequences of critical life events (DiPrete 2002). This literature has informed the comparative arguments advanced in the present dissertation. Conversely, my research contributes to this general line of research and extends it to social disparities in health across lives and cohorts.

The Swedish context

Sweden constitutes one of the sharpest contrasts to the U.S. in terms of social policies targeting disparities in health-related resources. Unlike the U.S., Sweden ranks among the most successful countries in minimizing inequality in educational opportunity, occupational instability, economic means, risky health behaviors, access to health care, and exposure to stress after adverse life events. If these policies are effective, they may slow down or even offset the process of cumulative (dis)advantage. Although the Swedish welfare state has experienced some cutbacks and a tendency of liberalization has emerged in social security, health care, and the labor market since the 1990s (Fritzell 1993; Fritzell and Lundberg 2007; Freeman et al. 2010), the magnitude of these changes is much smaller than in the United States. With respect to various health-relevant factors, Sweden still ranks among rather equal societies, whereas the U.S. are widely regarded as highly unequal (Bambra and Beckfield 2012). Comparing the Swedish and the U.S. context thus offers a unique opportunity to test the general implications of context-dependency in the cumulative (dis)advantage process.

These considerations are guiding Chapters 2 and Chapter 3. *Chapter 2* is a case study of cumulative (dis)advantage in Sweden. I used longitudinal data from the Swedish Level of Living Survey (LNU), spanning a period of almost 20 years (1991 until 2010). These data allowed me to trace changes in educational and occupational disparities in self-rated health and in the number of mobility limitations. To allow for cross-national comparisons, my study closely resembled the analytic strategy of one of the most influential empirical studies from the U.S. (Willson et al. 2007). This study was based on the PSID data, which are regarded as comparable with the Swedish LNU.

My results showed that gaps in self-rated health increased over the life course in Sweden. This applied to differences between educational groups and between occupational classes. Unlike in the U.S., the rise in health inequality over the life course unfolded only until middle age. Above the age of 55, this trend came to a halt. Because selective attrition and mortality are unlikely to constitute a major influence before old age, this result indicated that the Swedish welfare state might be more effective in preventing further divergence of health gaps between socioeconomic groups. As no policy interventions are specifically targeted at social disparities in health above the age of 50, the Swedish life-course profile might reflect the beneficial effects of long-term exposure to institutional factors that compensate for social disparities in health-relevant factors.

A cross-cohort analysis revealed different trends for the two indicators of socioeconomic position: Between educational groups, health gaps widened across cohorts, and this change was driven by steeper declines among the lower educated; between occupational groups, health gaps narrowed across cohorts, and this change was driven by steeper declines among those in higher occupational positions. Although the latter result seems to contradict the former, these differences are consistent with developments throughout the 1990s. During the economic crisis, governmental cutbacks primarily concerned the public service sector, in which a large share of upper non-manual workers are employed. As a result, the working conditions of this group worsened in terms of mental and physical workload, job security, and opportunities to develop (Vingård et al. 2005), possibly accounting for faster health declines among non-manual workers in more recent cohorts (Kondo et al 2014).

In sum, this study has shown that socioeconomic differences in health increase with age even in one of the most egalitarian welfare states. Moreover, this pattern seemed to intensify, albeit only slightly, across cohorts. However, both the life-course and the cross-cohort patterns suggest that the increase of socioeconomic disparities across lives and cohorts is less pronounced as compared to the United States.

Chapter 3 is a follow-up to this investigation. In Chapter 2, I closely aligned my study with the designs used in previous studies from the U.S., but the results were still not fully comparable in view of data limitations. In Chapter 3, I addressed this limitation, offering the first comparative investigation of the cumulative (dis)advantage hypothesis in the U.S. and Sweden. The analysis was based on harmonized panel data from the Health and Retirement Study and the Survey of Health, Ageing and Retirement in Europe. Both surveys include samples of educational groups that are similar in size, belong to the same birth cohorts, are observed across the same historical period, and report on the exact same health measures. As a primary outcome measure, I traced changes in the number of chronic conditions among individuals aged 50 to 74.

The analysis yielded four central findings. First, health trajectories in both countries were consistent with the cumulative (dis)advantage hypothesis, as gaps between higher and lower educated individuals increased with age. Second, throughout the entire age range under study, educational disparities in health were much larger in the U.S. than in Sweden, suggesting that cumulative (dis)advantage hypothesis applied more strongly to this context. Third, cohort effects indicated that this pattern has intensified in the U.S., but not in Sweden. Unlike more recent Swedish cohorts who experienced the economic crisis of the 1990s during a vulnerable stage in their lives, my study cohorts in Chapter 3 experienced the "golden age" of the Swedish welfare state throughout major stages of their lives. Fourth, across all ages and cohorts, I found a striking pattern of cross-national differences in education and health: Chronic conditions were most prevalent among lower educated Americans, followed by higher educated Americans, lower educated Swedes, and higher educated Swedes. This finding is consistent with other studies that found substantial disadvantages in terms of life expectancy, chronic conditions and functional limitations even among wealthy and higher educated Americans as compared to Europeans (Avendano et al. 2009, 2010; Banks et al. 2006).

In sum, Chapter 3 showed that socioeconomic disparities in health unfolded to a lesser extent and at much better average levels of health in Sweden as compared to the U.S. Moreover, among the older cohorts included in my study, health inequality increased in the U.S., but not in Sweden. Confidence in these results is strengthened by specific analytical benefits of the study, which compared educational groups that belonged to the same birth cohorts, were observed in the same historical period, reported on the same health measures, were comparable in size in both countries, and were not affected by compositional change related to differential rates of attrition.

The German context

Compared to the U.S. and Sweden, Germany provides a more complex institutional context regarding the cumulative (dis)advantage hypothesis. Health inequality in Germany is shaped by two opposing social forces. On the one hand, Germany has one of the most selective and stratifying educational systems, inhibiting social mobility and strongly determining socio-economic positions in later life (Allmendinger 1989). On the other hand, a generous welfare state is designed to alleviate the resulting inequalities, comprising various measures that might inhibit divergence in health trajectories.

Unlike in Sweden, where no previous tests of the cumulative (dis)advantage hypothesis were available (Fritzell et al. 2007), a number of German studies exist. In support of the welfare state argument, these studies have found gaps to remain stable (Schöllgen et al. 2010) or even to decline with age (Knesebeck 2005; Schmidt et al. 2012; Schöllgen et al. 2010). This line of research, however, has remained largely disconnected from U.S. research and its conceptual and methodological advances. Specifically, studies were mainly based on cross-sectional designs precluding the separation of age and cohort effects. Consequently, the lack of empirical support for the hypothesis of cumulative (dis)advantage might be explained by the same shortcomings that had previously plagued U.S. studies on educational health inequality over the life course.

In light of this, *Chapter 4* presents a study that aims to disentangle life-course and cohort processes in the study of educational health disparities in Germany[4]. Specifically, I asked

[4] An earlier draft of this Chapter has been published as a working paper: Leopold, L., and T., Leopold. 2016. "Education and Health Across Lives and Cohorts: A Study of Cumulative Advantage in Germany",

whether educational health gaps increased with age, and whether this divergence – if present – intensified across cohorts. I explicate a framework that highlights differences between Germany and the U.S. in various health-relevant factors on which the hypotheses of cumulative (dis)advantage is based. These include the role of the educational system in reproducing initial advantages and disadvantages related to social origin and stratifying economic outcomes in later life; the role of the welfare state in targeting the steady increase of educational disparities in health-related resources over the life course; change over time in the distribution of health-relevant resources and the composition of educational groups; and the gendered structure of the life course differentially exposing men and women to the risk factors driving processes of accumulation.

The analysis was based on hierarchical linear models using annual panel data (1992 until 2013) of the German Socio-economic Panel Study (SOEP). I traced educational differences in trajectories of self-rated health, a measure that was available in almost every wave, and conducted robustness checks using a measure of physical health (SF-12 Physical Component Scale) that was available biannually between 2002 and 2014.

In contrast to previous cross-sectional evidence from Germany, my results supported the cumulative (dis)advantage hypothesis, as health gaps between higher and lower educated people widened with age. Using model comparisons I showed that seemingly persistent age patterns revealed their true (i.e., divergent) character only if cohort effects and their interactions with age and education were taken into account. My evidence illustrates how substantive conclusions regarding the cumulative (dis)advantage hypothesis change if age and cohort effects are disentangled.

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Further analyses revealed that the process of the cumulative (dis)advantage was gendered in the German context. Among women, educational gaps in health were small and remained stable with age. Moreover, this pattern of continuity did not change even in recent cohorts. Among men, educational gaps in health did not only widen rapidly with age, but also increasingly across cohorts.

These results contrast with U.S. findings (Ross and Mirowsky 2010; Pudrovska 2014) as well as with my own findings from Sweden, which suggested that divergent pattern did not only pertain to both sexes, but even more strongly to women. In research on health inequality, most theoretical formulations and empirical tests of the cumulative (dis)advantage hypothesis are still gender-blind. In view of these findings, greater attention to such differences is warranted, particularly in studies that examine whether evidence from the U.S. can be generalized to other societies. The opposing patterns found for the U.S., Sweden, and Germany provide evidence for the importance of structural forces that have differentially shaped health trajectories of men and women in these societies.

The designs and the results of all three studies are summarized in Table 2. The results were largely in line with my theoretical expectations, demonstrating the context-specific nature of socioeconomic disparities in health across lives and cohorts.

TABLE 2: SUMMARY OF MAIN RESULTS

Study/ Country	Data	Period	Age range	Measure(s) of SES	Measure(s) of health	Results	
						Age patterns	Cohort patterns
Chapter 2 Sweden	LNU	1992-2010	25-75	Education Occupation	Self-rated health Mobility limitations	Divergence until age 55 Continuity from age 55 onwards	Increase of divergence between educational groups Decrease of divergence between occupational groups
Chapter 3 Sweden, USA	SHARE HRS	2004-2013	50-74	Education	Chronic conditions	Divergence with age in both countries; more pronounced in the U.S.	Increase of divergence in the U.S. No cross-cohort changes in Sweden
Chapter 4 West Germany	SOEP	1992-2013	25-85	Education	Self-rated health Physical health (SF-12)	Divergence with age among men Continuity among women	Increase of divergence among men Continuity among women

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Chapter II

Cumulative (Dis)advantage in an egalitarian country? Socioeconomic health disparities over the life course in Sweden

Abstract

According to the cumulative (dis)advantage hypothesis, health gaps between socioeconomic groups widen with age. In the United States, studies have supported this hypothesis. Outside this context, evidence remains scarce. The present study tests the cumulative (dis)advantage hypothesis in Sweden – a society that contrasts sharply with the United States in terms of policies designed to reduce social disparities in health-related resources. I draw on longitudinal data from the Swedish Level of Living Survey (*N* = 9,412 person-years), spanning the period between 1991 and 2010. The results show that gaps in self-rated health increase from early to middle adulthood. This applies to differences between educational groups and between occupational classes. In older age, health gaps remain constant. Cross-cohort analyses reveal an increase of health differences between educational groups, but not between occupational classes.

Introduction

The cumulative (dis)advantage hypothesis (CA) posits that socioeconomic position achieved early in life determines the amount of health-related resources and the exposure to environmental and social risks. Initial differences accumulate over time, leading to an increase of socioeconomic health disparities over the life course (Ross and Wu 1996; Willson, Shuey, and Elder 2007). Recent studies have supported this hypothesis. For different indicators of socioeconomic position and a variety of outcome measures, health gaps were found to widen with age (Kim and Durden 2007; Mirowsky and Ross 2008).

Although the CA hypothesis has received much attention over the past decades, the evidence remains limited in scope. Specifically, most findings in support of CA are based on data from the United States. This context provides favorable conditions for processes of cumulative (dis)advantage to unfold: lack of social security, unequal access to health care, and large social disparities in quality of living. This contrasts sharply with social policies in Western Europe and especially in Scandinavian countries, which target social equality in health-related resources. If these policies are effective, they will slow down, or even offset, the process of CA.

Extant research offers only minimal insight into whether, and to what extent, the CA hypothesis applies in societies other than the United States (van Kippersluis et al. 2010). The relevance of this question is twofold. First, it situates the CA process within different institutional settings, allowing to explore whether the explanatory scope of this hypothesis extends beyond the U.S. context. Second, considering the vast cross-country differences in social stratification and welfare state intervention, answers to this question may advance our understanding of how social disparities in health emerge, and under which conditions they can be expected to change.

In view of that, the present study aims to test the CA hypothesis in Sweden – a society which offers one of the sharpest contrasts to the U.S. in terms of policies designed to reduce social disparities in working conditions, financial resources, exposure to stress associated with adverse life events, risky health behaviors, and access to high-quality health care. The success of Sweden in reducing social inequality in these health-related resources may undermine the CA process. Yet, we lack empirical insight into these considerations.

To fill this gap, I draw on longitudinal data from the Swedish Level of Living Survey (LNU), covering a period of 20 years between 1991 and 2010. I use logistic panel regression models to examine life-course trajectories in self-rated health of 3,683 respondents from over 20 birth cohorts. To test the CA hypothesis, our analysis focuses on whether, and to what extent, health gaps between socioeconomic groups – measured by education and occupational class – increase over the life course.

The cumulative (dis)advantage hypothesis

The cumulative (dis)advantage framework highlights the mechanisms of path dependence and cumulative exposure by which initial disparities in different resources are expected to increase over time (Merton 1968; Elder 1998; DiPrete and Eirich 2006). Applied to social inequality in health, the CA hypothesis starts from social disparities in early life, which emerge from a path dependency between parental socioeconomic background, education, and subsequent placement in the occupational hierarchy. According to the hypothesis, these early disparities influence the distribution of advantages and disadvantages as well as the onset and duration of exposure to environmental and social risks across the life course. As a result, initial health gaps widen as individuals age (Ben-Shlomo and Kuh 2002; Dannefer 1987; Ross and Wu 1996).

In empirical research, the CA hypothesis has long been contested. Although it received some support (Ross and Wu 1996), other findings were inconsistent with the expected divergence of health trajectories between educational groups. Instead, convergence was found (House et al. 1994).

Analysts who reported converging health gaps advanced the competing hypothesis of “age-as-leveler.” This hypothesis highlights the importance of social policy interventions such as Medicare, providing more equal access to health care, and Social Security, alleviating economic inequality in older age (Dannefer 1987). It also emphasizes selection processes that result from elevated rates of mortality and health decline among people in lower socioeconomic groups. As a result, only the more robust of them continue to be observed in surveys, whereas individuals in higher socioeconomic groups remain largely unaffected by selective attrition (Wilkinson 1986).

The latter factor was found to be partially responsible for the observation of seemingly converging health gaps in later life (Noymer 2001). To address this source of bias, analysts have underscored the importance of longitudinal designs, which allow to account for selective attrition. In cross-sectional data, older respondents of a lower socioeconomic background might constitute a highly selective group of robust individuals.

Another problem of cross-sectional data is that they may suppress potentially diverging health trajectories among younger and middle-aged people, as age and cohort effects cannot be separated. The problem of confounding age and cohort gives rise to actual – rather than selection-driven – cohort differences in socioeconomic health trajectories. Lynch (2003) has shown that health trajectories of educational groups vary markedly across cohorts. Hence, an adequate test of the cumulative (dis)advantage hypothesis must disentangle age and cohort effects. U.S. studies that are based on such designs have provided unequivocal support for the cumulative (dis)advantage hypothesis (Kim and Durden 2007; Lynch 2003; Mirowsky and Ross 2008; Willson et al. 2007).

The mechanisms behind this pattern are complex, as health-related advantages and disadvantages of socioeconomic positions emerge in multiple forms over the life course. Although no single study can account for all mechanisms, a growing body of research provides insight into the main forces driving the CA process in the U.S. context.

Advantages and disadvantages of socioeconomic position for health are present already in the prenatal stage, as preterm birth and low birth weight are stratified by mothers' education (Bradley and Corwyn 2002). A growing body of literature shows that health problems emerging in these early periods cannot be fully compensated later in life (Barker 1998, O'Rand and Hamil-Luker 2005). During childhood, parental education and financial means affect nutrition and physical exercise, exposure to stress associated with family disruption (Wickrama, Lorenz, and Conger 1997), and experience of economic hardship (Case, Lubotsky, and Paxson 2002), as well as health-related psychological resources such as self-control, problem-solving skills, and the ability of learning (Mirowsky and Ross 2007).

These early-life disparities are intensified by the school system. Educational institutions reproduce and structure early advantages and disadvantages of social background and channel individuals' into the occupational hierarchy (Kerckhoff 1995). Occupational position in adult life, in turn, influences further work-related health hazards, such as financial stress, risk of job loss, and exposure to straining work environments.

Educational and occupational stratification, however, is not only associated with work-related health risks, but also with disparities in the experience of other disruptive events, such as marital breakup, loss of a spouse or parent, and single motherhood (Evans and Kim 2010). In lower socioeconomic groups, these life events are not only more prevalent, but their adverse effects are also magnified, as they often induce economic pressure, competing demands, and possibly adoption of unhealthy coping strategies coupled with a lack of financial and emotional support available in social networks (Ross and Mirowsky 1999).

Finally, even in absence of critical life events, higher and lower socioeconomic groups differ in their health behaviors. For instance, lower educated people are more likely to adopt risky health behaviors such as smoking, drinking, lack of physical exercise, and unhealthy nutrition earlier in life. They are also less successful in changing such habits, even after severe diagnoses (van der Wel, Dahl, and Thielen 2011). The impact of these risky behaviors on health and mortality has been shown to accumulate, depending on timing of onset and duration (Ferraro and Kelley-Moor 2003).

In the U.S. context, socioeconomic gaps in these health-related factors have been shown to widen throughout the life course (McLeod et al. 2012). Moreover, educational differences in income, wealth, and the prevalence of risky health behaviors have increased over time, producing even stronger divergence in age trajectories of health and mortality across cohorts (Goesling 2007; Lauderale 2001).

The cumulative (dis)advantage hypothesis in the Swedish context

Empirical evidence in support of the cumulative (dis)advantage hypothesis pertains almost exclusively to the U.S. context. Obviously, these findings cannot be simply generalized to other developed societies. A key issue is the extent to which the welfare state compensates for socioeconomic differences in the factors that are known to increase health inequality over the life course. Among such compensation policies are protection against adverse working conditions, public support after negative life events, and intervention against risky health behaviors (Bambra and Beckfield 2012).

In this regard, Sweden represents a particularly interesting national context, as it offers a sharp contrast to the U.S. (DiPrete 2002; Esping-Andersen 1999). First, unlike the U.S., Sweden aims to reduce economic inequality by compressing pre-taxation wages and redistributing taxes via the social security system. Since decades, income inequality and poverty rates in Sweden rank among the lowest in the world (Esping-Andersen 1999; Fritzell et al. 2013; OECD). Moreover, Swedish labor market policy is successful in reducing inequality in working conditions. For instance, Swedish employees of all occupational groups are entitled to 25 days of paid vacation, and an unlimited number of sickness days are covered by the employers or social security. In the U.S., there are no such guarantees. As a result, these benefits are strongly stratified: professionals receive an average of 20 paid vacation days, compared to only 13 days among blue-collar and service workers (Jorgensen 2002). Another important contrast concerns labor market regulations. In Sweden, employers are encouraged to offer permanent full-time contracts. Most of Swedish employees remain in stable employment until the retirement age of 65, irrespective of socioeconomic status (Mayer 2005). Taken together, these differences suggest that a main set of explanatory factors behind the CA hypothesis – socioeconomic disparities in working conditions and economic means– are less influential in shaping health inequality in the Swedish context.

Second, in contrast to the U.S., Sweden has a long tradition of supporting individuals and families to ease the consequences of critical life events. A variety of social policy measures aim at reducing stress related to family conflict, work-family imbalance, and financial hardship. These include universal access to publicly funded childcare, support with job returns after parental leaves, and compensation for material losses after family disruption (Esping-Andersen 1999). Moreover, the Swedish social security system is one of the most generous in covering cost of living in case of short-term and long-term unemployment or disability, including costs of housing, food, clothing, and health care (OECD). In addition, universal access to high-quality health care compensates for the consequences of negative life events such as serious illnesses (van der Wel et al. 2011). The Swedish welfare state provides this type of support regardless of age. This is in contrast to the U.S., where people may benefit from programs such as Medicare and Social Security only at older ages. Taken together, these considerations suggest that social disparities in health-related effects of negative events – the second set of factors highlighted by the CA hypothesis – are also less relevant in the Swedish context.

Third, in contrast to their U.S. counterparts, Swedes benefit from social policy measures which effectively prevent risky health behaviors. Although there are only few studies on inequality in risky health behaviors that compare the U.S. and Sweden, they suggest that socioeconomic disparities in smoking, overweight, and obesity are considerably smaller in Sweden as compared to the U.S (Pierce 1989; Power et al. 2005). These patterns indicate that a third set of factors behind the CA hypothesis – socioeconomic differences in the adverse effects of risky behaviors – might be far less influential in Sweden than in the United States.

A final important consideration are cohort trends. In the U.S., studies have found CA to apply even more strongly in recent cohorts. This finding has been attributed to a sharp and steady rise in economic inequality since the 1970s and, more recently, also in socioeconomic disparities in risky health behaviors (Mirowsky and Ross 2008). In Sweden, inequality in these health-related resources has increased only moderately across cohorts. Since the 1990s, the Swedish welfare state has experienced some cutbacks, and a tendency of liberalization has emerged in social security, health care, and the labor market (Freeman et al. 2010). Although these changes might favor processes of CA, their magnitude is still substantially smaller than the trends found in the United States (Bambra and Beckfield 2012; Fritzell et al. 2007; Fritzell and Lundberg 2007).

In summary, these considerations cast doubt on the validity of the CA hypothesis in the Swedish context. Instead, they broadly suggest that health-related advantages of higher socioeconomic groups and health-related disadvantages of lower socioeconomic groups are unlikely to accumulate over the life course. Consequently, I hypothesize the following: *In the Swedish context, socioeconomic gaps in health are small and do not widen with age.*

Evidence on health inequality in Sweden

Empirical studies on health inequality in Sweden are limited to cross-sectional and short-term follow-up analyses of health and mortality (Kjellsson 2012; Kondo, Rostila, and Aberg 2014). Some of these studies have reported that differences between occupational and educational groups in self-rated health and mortality are smaller in Sweden than in other countries such as the U.K. (Mackenbach et al. 2008). A recent cross-country analysis of inequality in mortality has listed Sweden among the least unequal societies (Popham, Dibben, and Bambra 2013). These findings, albeit cross-sectional, suggest that the CA process might indeed be attenuated in this context. Yet, the empirical picture is not consistent. Other studies have found that socioeconomic differences in health and mortality are particularly strong in Sweden and other egalitarian countries (Eikemo et al. 2008). These results have been termed the “Nordic health paradox” (Mackenbach 2012).

Because all of these studies are based on cross-sectional or short-term longitudinal data, they cannot provide adequate insight into the CA process in Sweden. As demonstrated in research from the U.S., such designs are prone to bias in the estimation of age trajectories in health. First, these designs may suppress increases in the magnitude of health gaps over the life course, as they ignore selection processes related to socioeconomic position and health at different ages (Beckett 2000). Second, these designs cannot separate age and cohort effects.

Because this separation is an important analytical requirement for the unbiased estimation of health trajectories (Lynch, 2003), an adequate test of the CA hypothesis in the Swedish context requires long-term longitudinal data.

Data and method

Sample selection

My analysis is based on data from the Swedish Level of Living Survey (LNU), a large-scale, representative household and individual study (Erikson 2014). In 1968, the LNU recruited a sample of Swedish individuals aged 15 to 75. This sample has been followed up and refreshed across five further waves conducted in 1974, 1981, 1991, 2000 and 2010. Since 1991, the LNU collects information on self-rated health. My analysis draws on these data from an observation period between 1991 and 2010, yielding up to three measurements of self-rated health per respondent, and spanning up to 20 years of life.

The LNU sample from the waves 1991, 2000 and 2010 comprised 9,111 individuals. I limited this sample to native Swedes (n = 8,520) to ensure that respondents were exposed to similar socio-historic conditions throughout their life courses. Furthermore, I restricted the age range of respondents to an interval of 24 to 56 (n = 4,156) in the anchor year of the study (1991). The lower age bound was used to ensure that most of the respondents had already completed their education and entered the life stage of establishing their socioeconomic position. The upper age limit ensured that observation windows for each study cohort had equal span (see below). Because the LNU does not collect further data after individuals reach the age of 75, the oldest respondents who could be followed up over the whole observation window were aged 56 in 1991. Finally, I excluded 473 respondents who did not provide valid information on self-rated health in any of the three waves. After all restrictions, my analytic sample consisted of

3,683 respondents. Because the majority of this sample (77%) were followed up over the entire observation period, this sample comprised 9,412 observations (i.e., person-years).

The LNU data combine a large range of cohorts with an extensive window of panel observations. A major benefit of these data is that they allow for two types of analyses: first, a joint model in which cross-cohort change is captured by interactions with age and measures of socioeconomic position – a common approach in analyses of cumulative (dis)advantage (Willson et al. 2007); second, separate models in which socioeconomic health trajectories are analyzed for different groups of cohorts. The large age overlaps of cohorts enabled me to complement the first approach by the second, which yields a more nuanced picture of cohort effects. For these separate models, I assigned respondents to three groups of birth cohorts, 1935 to 1945, 1946 to 1956, and 1957 to 1967. These cohort groups are equal in span and constitute meaningful groups, as their life courses were shaped by similar socio-historical conditions.

Measures

Measures of health

My outcome variable, *self-rated health* (SRH), is widely regarded as a valid measure of health. This measure is highly correlated with morbidity and strongly predictive of mortality (Idler and Benyamini 1997). In the LNU, data about SRH are based on the survey question "How would you describe your current health?" Respondents received three response options: "good", "bad", and "something in between." I dichotomized this variable to distinguish between good health and the remaining categories. This measure allowed me to estimate age trajectories in the probability of reporting good health in different socioeconomic groups.

In additional analyses, I used an alternative measure of health, indicating whether respondents reported at least one mobility limitation in walking, climbing stairs or running. Studies have argued that compared to SRH, mobility measures are more sensitive to health declines in old age. Furthermore, the reliability of mobility measures may be less dependent on education. To assess the robustness of our findings on SRH, I replicated all models using the measure for mobility limitations. These analyses led to the same substantive conclusions. The results on this alternative measure are included in the Appendix (Figures A1, A2, and A3).

Measures of age and cohort

For the multivariate analyses of the total sample, I centered the *cohort* variable at the median age of entry, equaling zero for those who were 40 years old in the year 1991 (i.e., born in 1951). *Age* was measured in years. For the analysis of the total sample, I centered the age variable at the grand median of 48 years. For the cohort-specific analyses, I centered age at the minimum value of each cohort. Similar to U.S. studies (Willson et al. 2007; Lynch 2003), a linear function provided the best representation of age effects on health trajectories in all multivariate models. Table 1 presents descriptive statistics for the total sample and separately by cohort groups.

Measures of socioeconomic position

I measured socioeconomic position by two indicators, education and occupational class in early adulthood. Most studies from the U.S. have used education to distinguish between socioeconomic groups, as this measure is stable over the adult life course, comparable across cohorts, defined for the total population (not only for the working population), and highly predictive for socioeconomic position in middle and late stages of life (Ross and Wu 1995). It is important to note, however, that the link between education and occupational position is relatively weak in Sweden (DiPrete 2002). To account for this, I used an indicator for occupational position in addition to the measure of education. Figure 1 illustrates the importance of this distinction in terms of defining socioeconomic groups. Only 55% of individuals with lower levels of education (secondary or less) are also in lowest occupational class of skilled and unskilled manual workers. Conversely, only about half of respondents with tertiary education also hold a position in the upper non-manual class.

Moreover, unlike in the U.S., high social mobility after completion of education is followed by high stability of occupational position. Once established at the labor market, most Swedish workers remain in full-time employment until retirement (Sackmann 2001). Hence, occupational position attained in early adulthood can be considered a strong indicator for the accumulation of health-related advantages and disadvantages over the life course.

TABLE 1. DESCRIPTIVE STATISTICS: TOTAL SAMPLE AND SEPARATELY BY COHORTS

	Total				Cohort											
					1935-45				1946-56				1957-67			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Self-rated health[a]	.76		0	1	.67		0	1	.77		0	1	.83		0	1
Age[b]	47.8	12.0	24	75	58.8	8.30	46	75	48.8	8.39	35	64	37.3	8.45	24	53
Age (minimum-centered within cohorts)					12.8	8.30	0	29	13.8	8.39	0	29	13.3	8.45	0	29
Year of birth	1952	9	1935	1967	1941	3	1935	1945	1951	3	1946	1956	1962	3	1957	1967
Cohort (age at first wave)	40	9	24	56	51	3	46	56	40	3	35	45	29	3	24	34
Education																
< Secondary	.68				.75				.68				.62			
Post-secondary	.17				.12				.18				.21			
Tertiary	.15				.12				.14				.17			
Occupational class																
Manual	.43				.43				.42				.44			
Self-employed & farmers	.10				.09				.11				.09			
Middle non-manual	.34				.37				.35				.32			
Upper non-manual	.12				.10				.11				.15			
Controls																
Male	.52				.52				.50				.53			
Dropout before 2010	.25				.27				.25				.24			
Number of waves	2.56	.67	1	3	2.53	.68	1	3	2.57	.66	1	3	2.57	.67	1	3
Number of respondents		3,683				1,107				1,311				1,265		
Number of observations		9,412				2,797				3,371				3,244		

Note: Swedish Level of Living Survey (1991–2010). [a] Binary variable: 1 = good health, 0 = bad health and somewhere in between. [b] In models M1 and M2 centered at the median age of 46.

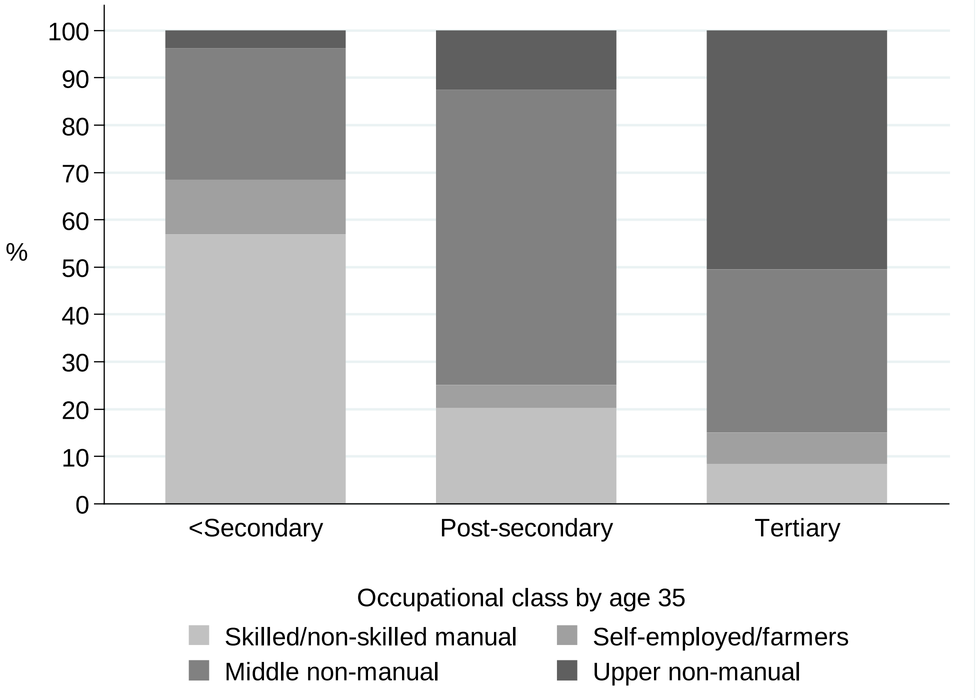

FIGURE 1: DISTRIBUTION OF OCCUPATIONAL CLASSES WITHIN EDUCATIONAL GROUPS
Note: Swedish Level of Living Survey (1991–2010). Skilled and non-skilled manuals: workers in service or production, such as cook, mover, packer. Self-employed and farmers: self-employed with up to 20+ employees; farmers with up to 100 hectares arable land. Middle non-manual: routine and supervisory non-manual tasks, such as shop assistant, insurance salesman, bookkeeper. Upper non-manual: professionals, such as teacher, lawyer, doctor.

I used a categorical approach to measure *education*, drawing on information on respondents' highest level of education, which was collected from administrative registers in 2010. This information was available for all respondents who participated in at least one of the panel waves. Figure 2 shows the distribution of education across cohorts. The group of respondents with primary education comprises individuals with education equal to or less than compulsory school (i.e., approximately 9 years of schooling). The group of respondents with secondary education consists of individuals with upper secondary degrees (*gymnasium, fackskola*, *yrkesskola*). Post-secondary education includes those who received at least some vocational training or attended university, but have not attained a university degree. Finally, the category of tertiary education includes those who hold a university degree equivalent to bachelor or master level. As the figure shows, educational expansion involved a shift primarily from lower to intermediate levels of education, whereas the proportion of higher educated individuals has remained largely constant.

In the most recent cohort, less than 10% of respondents belonged to the group of primary educated individuals, as compared to 20% in the middle and almost 40% in the earliest cohort. In view of that, it appears questionable whether these groups are comparable with regard to their health-relevant characteristics. In particular those of the most recent cohort might constitute a group that is more negatively selected. For that reason, I combined the categories of primary and secondary education into one group of lower educated individuals. As shown in Figure 2, the size of this group is more similar across cohorts.

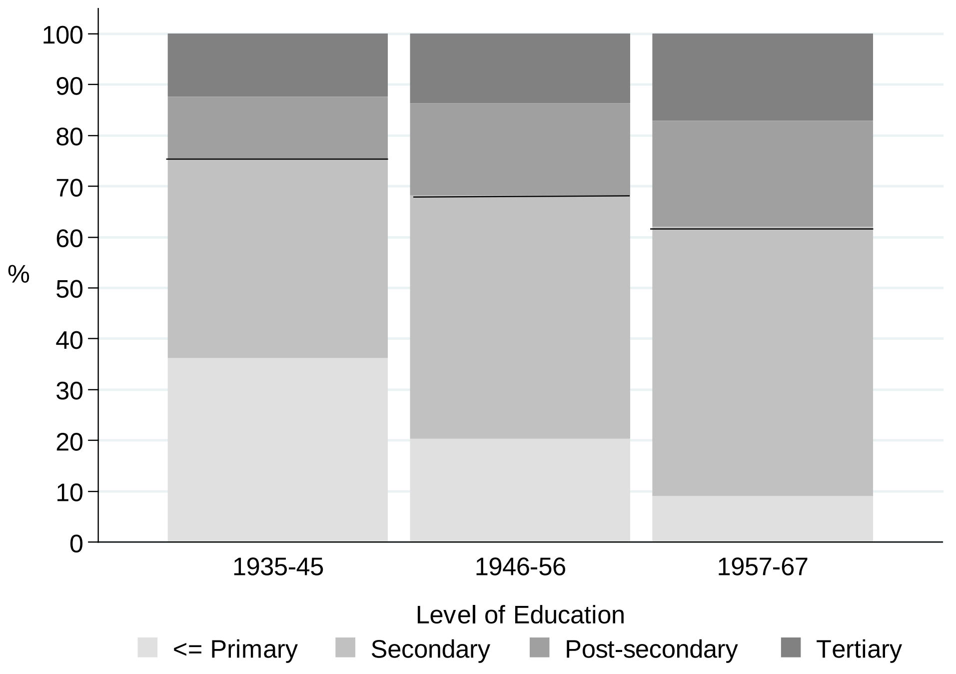

FIGURE 2: DISTRIBUTION OF EDUCATIONAL LEVELS BY COHORT

Note: Swedish Level of Living Survey (1991–2010).
<= Primary: compulsory school or less. Secondary: upper secondary degrees such as gymnasium, fackskola or yrkesskola. Post-secondary: secondary degree and vocational training or not completed university studies. Tertiary: equivalent to bachelor, master or higher levels.

My measure of *occupational class* refers to socioeconomic position at the age of 35.[1.] I chose this age because previous studies have shown that occupational class is unlikely to change later in life (Härkönen and Bihagen 2011). Information about occupational class at different ages was collected retrospectively in each wave and operationalized using a socioeconomic classification constructed by Statistics Sweden (see Statistiska Centralbyrån 1984). This index is similar to the EGP classification and widely used in Swedish research (Härkönen and Bihagen 2011). In my analysis, I distinguish between four classes: upper non-manual; middle (including lower) non-manual; self-employed and farmers; and skilled and unskilled manual workers.

Controls

Our models control for *gender*, gender differences in age trajectories – measured by an interaction between *gender and age* –, and *dropouts* from the panel.[2] As explained above, selective dropouts may potentially bias my results if not controlled. To account for the possibility that dropouts were in worse initial health compared to those remaining in the panel, I used a time-constant indicator variable for whether respondents had left the panel before the most recent wave of 2010 (see Chen, Yang, and Liu 2010).

Analytic strategy

I estimate population average (PA) logistic panel regression models (Liang and Zeger 1986) to assess socioeconomic differences in my binary outcome measure. The PA model focuses on differences between groups of individuals, accounting for the autocorrelation structure at the level of individuals. My data included up to three observations per person, measured at ten-yearly intervals. In the PA model, I define the autocorrelation of these observations within persons as unstructured. This specification allows for most flexible modelling (Szmaragd, Clarke, and Steele 2013). The equation of the model is included in the Appendix. Within a logistic panel regression framework, the PA method closely resembles the linear growth curve approach, which has been used in most previous tests of the cumulative (dis)advantage hypothesis (Lynch, 2003; Willson et al. 2007; Mirowsky and Ross 2008).[3.] Similar to previous studies, my empirical model includes measures of age, cohort, socioeconomic position, and two-fold and three-fold interactions between these variables.

Although my data track individuals over an exceptionally long period of time, they do not cover the entire life courses of different birth cohorts. Hence, the model for the overall sample combines individual trajectories which start and end at different ages into one extrapolated cohort to estimate change in health across the entire age range. Although cohort effects are modeled by interactions, differences can only emerge within the parametric constraints of a joint model. To overcome this restriction, I estimate a further set of models separately for the three cohort groups. This approach allows for more flexibility in age trajectories within each cohort, and in patterns of change across cohorts. I estimated identical models for both measures of socioeconomic position – education (Table A1) and occupation (Table A2) – for the total sample (M1, M2) and for each of the three cohorts (M1a, M1b, M1c; M2a, M2b, M2c).

For the interpretation of my results, I transform the logit coefficients into predicted probabilities of reporting good health. Unlike logit coefficients or Odds Ratios, predicted probabilities are informative with regard to change in absolute levels of health. This type of information is necessary for an adequate test of the CA hypothesis, which expects absolute health gaps between socioeconomic groups to widen with age. After conversion to predicted probabilities, however, the direction, magnitude, and statistical significance of interaction effects cannot be inferred directly from the coefficients and their standard errors (Ai and Norton

2003; Greene 2010). [4] The main reason for this is the non-linear transformation of the unbounded linear logit coefficients into predicted probabilities, which range between 0 and 1 (Berry, DeMeritt, and Esarey 2010).

I calculate predicted probabilities for being in good health and their confidence intervals from the logit estimates for different socioeconomic groups at different ages and in different birth cohorts. These results are shown in Table 2 for education and in Table 3 for occupational class. In Figures 3 and 4, illustrate my main results graphically, showing predicted probabilities along with their confidence intervals. This allows me to evaluate the precision of my estimates across the age range under study (Greene 2010). Tables A1 and A2 in the Appendix include the initial logit estimates on which the graphs shown in the figures are based.

Results

The findings presented in Table 2 and Table 3 provide answers to the guiding question of the analysis, namely whether educational and occupational health trajectories in Sweden are consistent with the cumulative (dis)advantage hypothesis or not. In these tables, I show predicted probabilities derived from the logistic panel regression models, which are detailed in the Appendix (Tables A1 and A2)

TABLE 2. MARGINAL PROBABILITIES OF GOOD HEALTH BY AGE AND EDUCATION

	Level of education		
Age	< Secondary	Post-secondary	Tertiary
25	.892 [.872, .911]	.935 [.921, .948]	.947 [.935, .959]
35	.837 [.818, .855]	.899 [.882, .915]	.917 [.902, .933]
45	.761 [.745, .777]	.846 [.825, .867]	.873 [.853, .893]
55	.664 [.641, .688]	.774 [.745, .803]	.810 [.782, .839]
65	.552 [.512, .592]	.680 [.638, .723]	.726 [.684, .768]
75	.435 [.379, .491]	.570 [.511, .629]	.623 [.563, .682]
Difference compared to < Secondary (in %-points)			
25		+4	+6
45		+9	+11
75		+14	+19
Change from age 25 to 75 (in %-points)	–46	–37	–32

Note: Swedish Level of Living Survey (1991–2010). 95% confidence intervals in brackets. Results are based on a logistic panel regression model with population average effects. See Model 1 in Table A1 for details. Marginal probabilities are calculated for the indicated levels of age and education, all other covariates held at their means.

I begin by examining educational health trajectories. Table 2 shows age-related change in the predicted probabilities of reporting good health separately for three educational groups. These point estimates and their 95% confidence intervals are conditional on covariates from Model 1 (Table A1). In contrast to my expectations, the results support the CA hypothesis, as educational health gaps widen with age. Initial health gaps are small: At the age of 25, the difference between lower and higher educated people in the probability of reporting good health amounts to less than 6 percentage points. Yet, by the age of 45, this difference has almost doubled; until the age of 75, it further increases to 19 percentage points. To assess the substantive size of these widening health gaps, it is instructive to compare the ages at which the proportion of respondents reporting good health within an educational group falls below the average level of the total sample (76%). Individuals with the lowest degrees cross this threshold already at the age of 45; those with post-secondary degrees at the age of 55; and those holding tertiary degrees shortly before the retirement age of 65 – almost two decades years later in life.

TABLE 3. MARGINAL PROBABILITIES OF GOOD HEALTH BY AGE AND OCCUPATIONAL CLASS

	Occupational class			
Age	Manual	Self-employed / Farmers	Middle non-manual	Upper non-manual
25	.878 [.851, .905]	.915 [.877, .954]	.935 [.919, .951]	.955 [.934, .976]
35	.817 [.792, .842]	.857 [.816, .898]	.899 [.882, .916]	.927 [.904, .950]
45	.733 [.712, .755]	.768 [.726, .810]	.847 [.829, .865]	.884 [.859, .910]
55	.629 [.600, .658]	.647 [.587, .708]	.774 [.748, .800]	.821 [.781, .861]
65	.511 [.463, .560]	.505 [.409, .601]	.681 [.635, .727]	.734 [.658, .809]
75	.393 [.327, .458]	.363 [.244, .483]	.571 [.499, .642]	.623 [.495, .751]
Difference compared to Manuals (in %-points)				
25		+4	+6	+8
45		+4	+11	+15
75		–3	+18	+23
Change from age 25 to 75 (in %-points)	–49	–55	–36	–33

Note: Swedish Level of Living Survey (1991–2010). 95% confidence intervals in brackets. Results are based on logistic panel regression model with population average effects. See Model 2 in Table A2 for details. Marginal probabilities are calculated for the indicated levels of age and occupational class, all other covariates held at their means.

For my second indicator of socioeconomic position – occupational class – Table 3 shows a similar pattern of findings. The divide is particularly strong between manual workers and self-employed/farmers on the one hand, and middle and upper non-manual workers on the other. The age-related increase in health gaps between the lower and higher occupational classes is comparable to the pattern found for educational groups. At the retirement age of 65, for example, almost three of fmy upper service class workers are still in good health, compared to only one of two among the manual classes.

Figure 3 visualizes these results, plotting predicted probabilities and their confidence intervals for educational groups (left panel) and occupational groups (right panel). In the upper part of the figure, I show age-related declines in the probability of reporting good health; in the lower part, I focus on differences between the lowest (reference line) and two higher socioeconomic groups. This allows not only to illustrate the main results, but also to better assess the precision of the estimates.

Health trajectories consistent with cumulative (dis)advantage emerge for both measures of socioeconomic position. Most of this divergence occurs between younger adulthood and middle age. After the age of 55, it levels off.

In the analyses presented so far, I fixed the cohort variable at the median value of 1951. To gain more insight into cross-cohort change, I compared socioeconomic health trajectories in three cohorts. The curves presented in Figure 4 are derived from separate models for each cohort. These models for education (Model 1a, 1b, and 1c) and occupational class (Model 2a, 2b, 2c) are detailed in the Appendix (Tables A1 and A2).

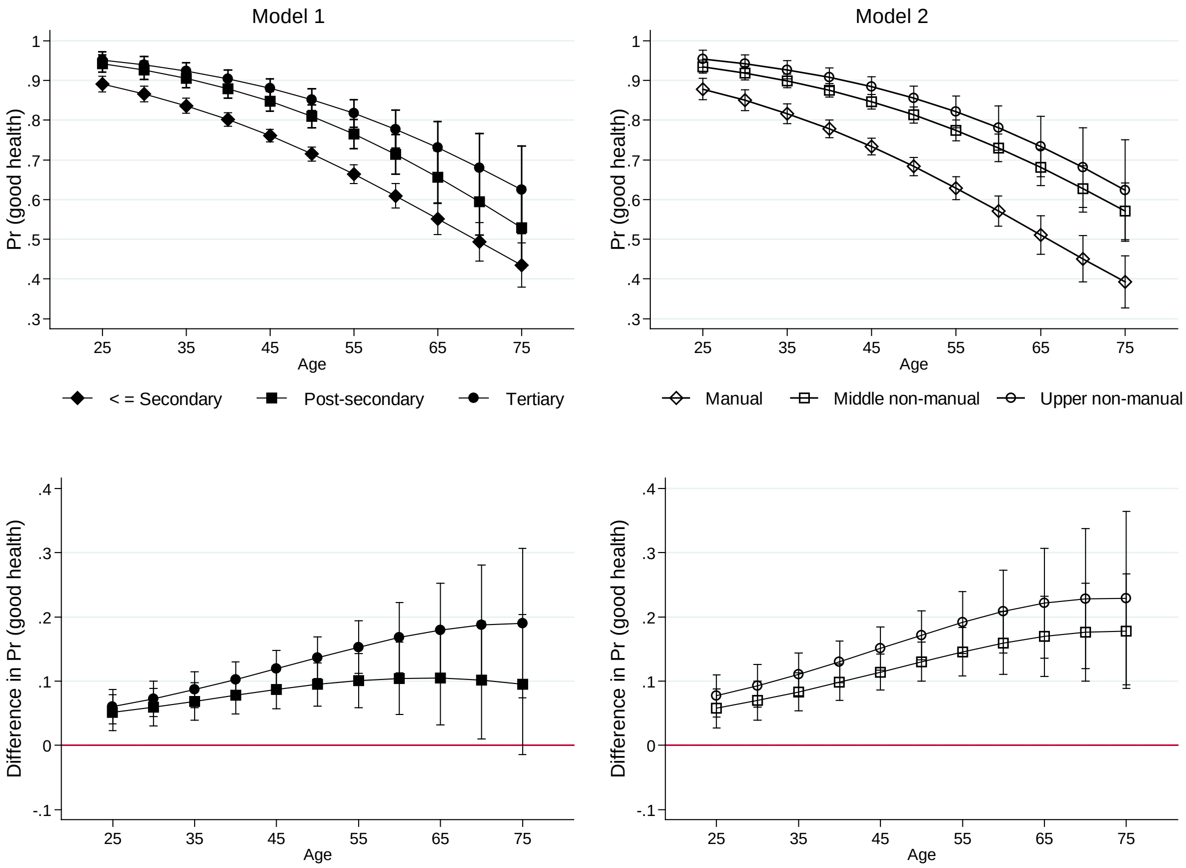

FIGURE 3: MARGINAL PROBABILITIES AND DIFFERENCES IN PREDICTED PROBABILITIES OF GOOD HEALTH BY AGE, EDUCATION AND OCCUPATIONAL CLASS

Note: Swedish Level of Living Survey (1991–2010). Predictions based on models M1 (education) and M2 (occupational class). Marginal probabilities (upper panels) and confidence intervals are calculated for given age values, educational groups, and occupational classes. The lower panels show estimated differences in marginal probabilities of reporting good health between those with secondary education and both higher educational groups (left lower panel) and between the manual class compared to middle non-manual and upper non-manual classes (right lower panel). Zero line indicates no difference. All other covariates are set to their means.

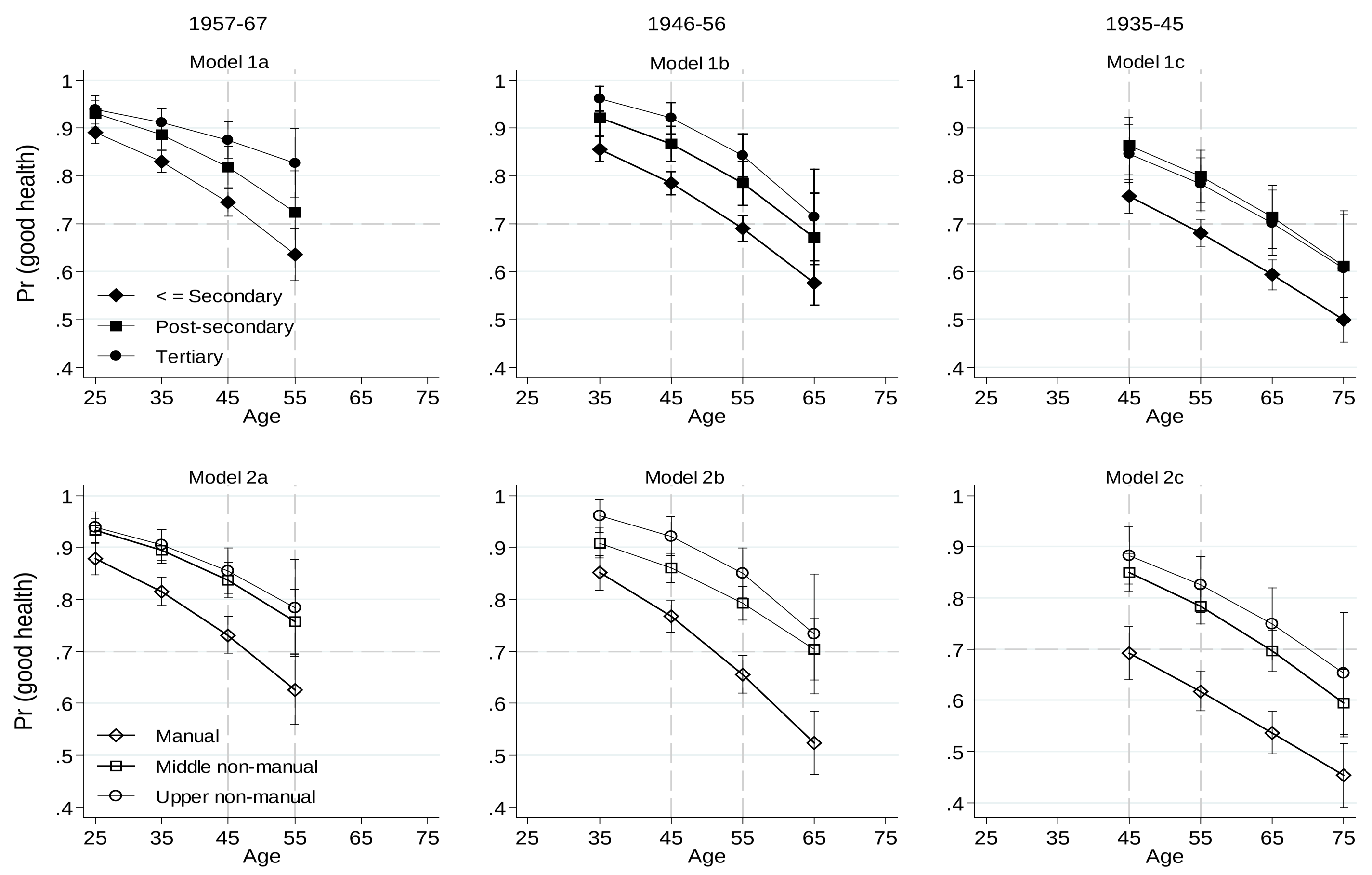

FIGURE 4: PREDICTED PROBABILITIES OF GOOD HEALTH BY AGE, EDUCATION, OCCUPATIONAL CLASS AND COHORT

Note: Swedish Level of Living Survey (1991–2010). Predictions are based on models M1a – M1c (education) and M2a – M2c (occupational class). Marginal probabilities and confidence intervals are calculated for given values of age, educational groups, and occupational classes. All other covariates are set to their means

Figure 4 shows two notable patterns. First, regarding education, divergent trajectories of health differences are most pronounced in the youngest cohort. In the other cohorts, health gaps are present at the initial age, but do not increase much across the age range covered. Results further show that differences between the lowest and the highest educational group tend to grow across cohorts: At the age of 55 – the highest overlapping age for which an estimate is available in all three cohorts – the difference between those groups in terms of predicted probabilities of reporting good health amounts to 10 percentage points in the earliest cohort, 14 in the middle cohort, and 16 in the most recent cohort. This increase is driven by steeper health declines of lower educated people of the most recent cohort as well as slower health declines among the higher educated in both the middle and most recent cohort.5 Because accumulation of differences in working conditions and economic means constitutes one of the main explanatory factors behind the cumulative (dis)advantage of education for health, I controlled for differences in occupational class and its interactions with age and cohort, as this measure is often used as a proxy for long-term economic standing and working conditions. As Figure A4 indicates, educational differences in health trajectories diminished substantially, but the life-course and cross-cohort patterns remained the same. Occupational differences, thus, constitute an important explanatory factor behind educational disparities in health trajectories.

Second, the patterns of findings for education does not hold similarly for occupational classes. Compared to educational patterns, the most notable difference emerges in the oldest cohort. In this cohort, health gaps are larger due to lower levels among manual workers. Across the two subsequent cohorts, educational and occupational patterns become more similar. However, I do not observe an increase in health gaps between occupational groups across cohorts. Instead, the health gap between manual and upper non-manual workers at the age of 55 even narrows from approximately 20 to 15 percentage points in the most recent cohort. This closing gap is due to concurrent tendencies of slight increases among the manuals and declines among the upper non-manuals. The confidence intervals at the overlapping ages, however, are sizable. That means that trends across cohorts are merely suggestive and must be treated with caution, given the uncertainty of my estimates.

In summary, the analysis yielded three central findings. First, health gaps widened with age, supporting the notion of cumulative (dis)advantage. Second, this divergence was limited to earlier and middle stages of the life course; after the age of 55, health gaps remained constant. Third, cross-cohort analyses revealed a rising importance of cumulative (dis)advantage between educational groups, but not between occupational classes.

Discussion

According to cumulative (dis)advantage theory, health gaps between socioeconomic groups emerge from broader patterns of social inequality. In this process, education and early occupational placement are seen to play a central role, as they reproduce initial social disparities and shape divergent health gaps over the life course.

In recent years, tests of the cumulative (dis)advantage hypothesis have been refined by greater attention to the social conditions in which individual health trajectories unfold. Although the context-specific nature of these processes is generally acknowledged, rigorous empirical tests of the cumulative (dis)advantage are almost entirely limited to U.S. studies.

The present investigation examined health inequality over the adult life course in Sweden, offering the first test of the cumulative (dis)advantage hypothesis in this national context. Sweden can be placed at the opposite pole from the U.S. with regard to institutional attempts to reduce socioeconomic differences in most of the factors that were found to be responsible for widening health gaps over the life course (DiPrete 2002). Therefore, I expected the cumulative (dis)advantage hypothesis not to apply in this context.

My results did not support this expectation. Socioeconomic differences in self rated health increased with age. Although health gaps were small initially, they widened considerably over time. The health of lower socioeconomic groups fell below the average level already in their mid-40s, whereas higher socioeconomic groups crossed this threshold only in their mid-60s. This applies to differences between educational as well as occupational groups.

These results are broadly in line with the patterns found in the U.S. A notable difference, however, emerged in later life stages. In the U.S., studies have reported health gaps to widen throughout older age (Mirowsky and Ross 2008; Kim and Durden 2007). In Sweden, the rise in health inequality over the life course unfolded until middle age. Above the age of 55, this trend came to a halt. This could indicate that the Swedish welfare state is effective in precluding further divergence of health gaps between socioeconomic groups. Yet, there are no specific policy interventions targeted at social disparities in health above the age of 50. In view of that, the pattern I found may rather reflect the beneficial effects of long-term exposure to institutional factors that compensate for social disparities in health-relevant factors.

An alternative interpretation is that health-based selection or selective cohort survival may account for continuous patterns in later life, as those who entered the panel at an older age contributed more to these estimates. If positive selection on health was stronger in lower socioeconomic groups, their actual health declines may be underestimated (Lynch 2003). In the present study, however, this mechanism did not appear to play a major role. First, even the oldest individuals in my study were not older than 55 years as they entered the panel – an age at which selective survival is unlikely to be influential. Second, the share of dropouts was similar in younger and older cohorts. Finally, there are no compelling theoretical reasons to suggest that selection mechanisms would operate in Sweden but not in the U.S.

A major benefit of my long observation window was that it allowed for detailed cross-cohort analyses. A notable finding from these analyses is a tendency of increasing cumulative (dis)advantage between educational groups, resembling results from the U.S. (Lynch 2003, Goesling 2007, Mirowsky and Ross 2008). This finding directs attention to more recent economic and institutional shifts in Sweden. In the 1990s, Sweden went through a severe economic crisis, the welfare state was pushed back, and a tendency of liberalization emerged in social security, health care, and the labor market (Freeman, Swedenborg, and Topel 2010). Although Sweden has remained near the top of equality rankings in international comparison, these shifts may still have affected the life chances and related-health outcomes among more recent cohorts, compared those who fully enjoyed the “golden age” of the Swedish welfare state (Lundberg et al. 2001). This interpretation is consistent with the strong educational gradient in employment chances among young adults during the economic crisis in the 1990s. As extant research shows, effects of unemployment and job instability accumulate over time, impacting on physical health (Korpi 2001). Throughout the 1990s, lower educated Swedes were more strongly confronted with job scarcity, as the employment rate of primary educated people fell by 35 percentage points, compared to only 15 percentage points among the higher educated (Aberg 2003).

A further notable finding to emerge from my cross-cohort analyses is that trends looked very different depending on the indicator used to separate socioeconomic groups: Between educational groups, health gaps widened across cohorts, and this change was driven by steeper declines among the lower educated; between occupational groups, health gaps narrowed across cohorts, and this change was driven by steeper declines among those in higher occupational positions. I found shrinking health gaps between occupational classes. Although the latter seems to contradict the former, these differences are consistent with developments throughout the 1990s. During the economic crisis, governmental cutbacks primarily concerned the public service sector, in which a large share of upper non-manual workers are employed. As a result, the working conditions of this group worsened in terms of mental and physical workload, job security, and opportunities to develop (Vingård, Lindberg, and Josephson 2005). These developments may account for faster health declines among non-manuals in more recent cohorts (Kondo et al 2014).

Yet, all of these interpretations about the cross-cohort trends observed in the present study remain speculative and require further investigation in the future research. Specifically, the role of increasing unemployment risks among the lower educated and the effects of more demanding working conditions among the upper non-manuals should be examined more directly on the basis of retrospective information in each cohort. Moreover, I consider it worthwhile to focus not only on differences between educational and occupational trends, but also on their interrelationship. Differences in health-related factors associated with occupation, for example, constitute one of the main explanatory links between education and health. Yet, if these differences decrease across cohorts, the role of occupation may become less central in explaining educational differences in health. Analyses of changes in the relative importance of explanatory mechanisms are still scarce (Lynch 2006), but carry high potential to advance my understanding of why social inequality in health changes across cohorts.

Looking at the overall picture of current life course research on health inequality, this study suggests, on the one hand, that the general life-course pattern postulated by the cumulative (dis)advantage hypothesis applies similarly in national contexts that vary greatly in the provision of welfare. On the other hand, my findings demonstrate that critical features of this process – such as the life stage in which divergent health trajectories unfold – are context-specific.

Although I closely aligned my study with the designs used in previous studies from the U.S., I note that results may not be fully comparable in view of data limitations. One potential problem of comparison concerns my outcome variable, self-rated health. Research has suggested that the validity of this indicator as measure of health may differ across national contexts. In the U.S., analysts have expressed concern that the measure of self-rated health may be biased when assessing the health of lower educated people (Salomon et al. 2009; Zajacova and Dowd 2011), although this kind of bias was much less pronounced in Swedish data (Lundberg and Manderbacka 1996). Measures of mobility limitations are considered to suffer less from measurement error. Although the LNU does not include comprehensive information on mobility, I could draw on a specific indicator for limitations in walking, running or climbing stairs as an alternative measure of health. These analyses led to the same conclusions.

Although this increases confidence in the present analysis, the findings about educational differences in self-rated health may not be fully comparable to those reported in U.S. studies. Even more importantly, the measure of self-rated health does not allow me to directly compare absolute levels of health and the size of health gaps between the two countries. A potential remedy to this is the use of more precise measures of general health such as the physical functioning scale (based on SF-36), indicators for specific symptoms, or mortality (Salomon et al. 2009). Comparative studies that are based on such measures of health may shed more light on important unresolved questions regarding cross-national differences in the magnitude of socioeconomic health gradients.

Notes

1. After these imputations, information about occupational class was missing for only in 0.7% of cases.
2. I tested for interactions between gender, age, cohort, and socioeconomic position. Although the inclusion of these interactions did not influence my main conclusions, cumulative (dis)advantage seemed to be more pronounced among women. This is in line with recent research on gender differences in socioeconomic gaps in mortality (Kondo et al. 2014). I were unable to conduct gender-specific analyses for the full range of cohorts, given the low case numbers of highly educated women in the oldest cohort (n = 65).
3. A further benefit of this approach is that it allows for a pattern of early and mid-life increase followed by late-life decrease of educational health gaps, as postulated by the age-as-leveler hypothesis. The parametric restrictions of an aggregated linear model would preclude the detection of such a pattern.
4. For robustness checks, I also estimated hierarchical linear probability models, which are directly comparable to the methods used by previous U.S. studies. With these models, I reached the same conclusions.
5. These results also hold if four categories of education are used. These analyses are show in Figure A3 in the Appendix.

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Appendix A: Tables and Figures

TABLE A1: LOG ODDS OF GOOD HEALTH ESTIMATED USING LOGISTIC PANEL REGRESSION (POPULATION AVERAGE EFFECTS)

	M1 Overall	M1a 1957-67	M1b 1946-56	M1c 1935-45
Age (centered)[a]	-.0477***	-.0563***	-.0598***	-.0371***
	(-11.67)	(-6.82)	(-8.32)	(-5.77)
Post-secondary[b]	.565***	.481	.639*	.698**
	(5.24)	(1.83)	(2.29)	(2.63)
Tertiary	.834***	.589*	1.438***	.565*
	(6.94)	(1.99)	(3.94)	(2.30)
Age*Post-secondary	-.00644	-.00213	-.00732	-.00839
	(-.79)	(-.16)	(-.52)	(-.59)
Age*Tertiary	-.00250	.0139	-.0278	-.00453
	(-.28)	(.96)	(-1.65)	(-.35)
Male	.232***	.248	-.0907	.142
	(3.53)	(1.21)	(-.48)	(.89)
Age * Male	.00189	.00962	.0223*	-.00179
	(.42)	(.93)	(2.38)	(-.21)
Dropout before 2010	-.560***	-.231	-.496***	-.798***
	(-6.99)	(-1.43)	(-3.55)	(-6.33)
Cohort median-centered	.00371			
	(.71)			
Age*Cohort	.000619*			
	(2.05)			
Cohort*Post-secondary	.0152			
	(1.21)			
Cohort*Tertiary	-.00649			
	(-.43)			
Age*Cohort*Post-secondary	-.000459			
	(-.65)			
Age*Cohort*Tertiary	-.00119			
	(-1.42)			
Constant	1.000***	2.054***	1.893***	1.163***
	(17.06)	(11.94)	(12.23)	(9.12)
Observations	9,041	3,107	3,243	2,691

Note: Swedish Level of Living Survey (1991–2010). Note*:* *t* statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; [a] In M1 age is centered at the grand median, in models M1a-M1c age is centered at cohort-specific means. [b] Reference category is secondary education or less.

TABLE A2: LOG ODDS OF GOOD HEALTH ESTIMATED WITH LOGISTIC PANEL REGRESSION (POPULATION AVERAGE EFFECTS)

	M2 Overall	M2a 1957-67	M2b 1946-56	M2c 1935-45
Age (centered)[a]	-.0486***	-.0541***	-.0670***	-.0333***
	(-9.83)	(-5.87)	(-7.81)	(-4.08)
Self-employed and farmers[b]	.162	.527	.105	.441
	(1.25)	(1.39)	(.37)	(1.46)
Middle non-manual	.711***	.644**	.488*	.910***
	(8.15)	(2.65)	(2.22)	(4.97)
Upper non-manual	1.031***	.762*	1.517***	1.198***
	(7.48)	(2.45)	(3.34)	(4.09)
Age*Self-employed and farmers	-.0106	-.0221	-.00275	-.0161
	(-1.07)	(-1.15)	(-.19)	(-.98)
Age*Middle non-manual	.000667	-.000193	.0112	-.0117
	(.10)	(-.02)	(1.03)	(-1.19)
Age*Upper non-manual	-.00331	.000135	-.0217	-.0131
	(-.33)	(.01)	(-1.00)	(-.85)
Male	.235***	.201	-.0841	.0894
	(3.50)	(.97)	(-.43)	(.54)
Age * Male	.00337	.0120	.0251**	-.0000728
	(.72)	(1.14)	(2.58)	(-.01)
Dropout before 2010	-.542***	-.228	-.469***	-.779***
	(-6.68)	(-1.40)	(-3.34)	(-6.03)
Cohort median-centered	-.00220			
	(-.34)			
Age*Cohort	.000631			
	(1.63)			
Cohort*Self-employed and farmers	.00927			
	(.58)			
Cohort*Middle non-manual	.00743			
	(.72)			
Cohort*Upper non-manual	.00991			
	(.62)			
Age*Cohort*Self-employed and farmers	.000110			
	(.11)			
Age*Cohort*Middle non-manual	-.000493			
	(-.86)			
Age*Cohort*Upper non-manual	-.00114			
	(-1.27)			
Constant	.840***	1.940***	1.848***	0.867***
	(12.70)	(10.11)	(10.48)	(5.79)
Observations	8,998	3,089	3,224	2,685

Note: Swedish Level of Living Survey (1991–2010). *t* statistics in parentheses; $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
[a] In M2, age is centered at the grand median, in M2a-M2c age is centered at the cohort-specific minimum.
[b] Reference category is skilled and non-skilled manual.

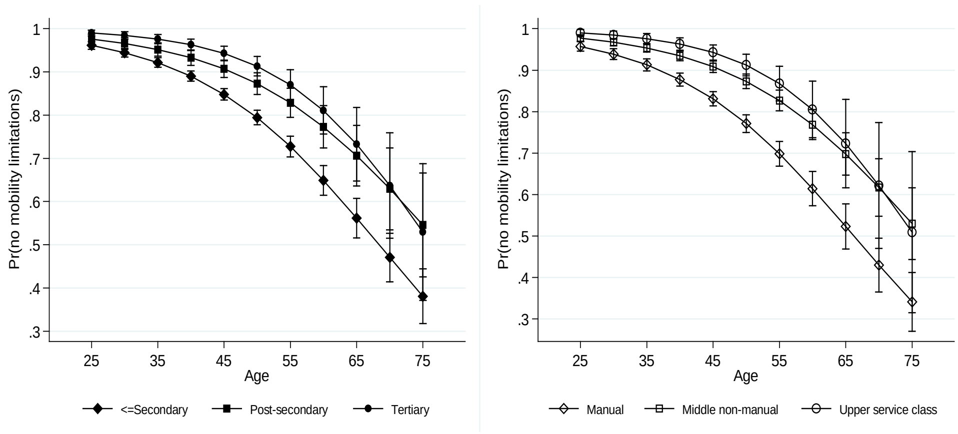

FIGURE A1

MARGINAL PROBABILITIES OF REPORTING NO MOBILITY LIMITATIONS
BY
EDUCATION AND OCCUPATIONAL CLASS

Note: Swedish Level of Living Survey (1991–2010). Predictions for mobility limitations are based on models analogous to M1 and M2. "No mobility limitations" is a dummy equaling 1 if a respondent reported no limitations in walking, running or climbing stairs, 0 otherwise. Marginal probabilities and confidence intervals are calculated for given values of age, educational group, and occupational class. All other covariates are set to their means.

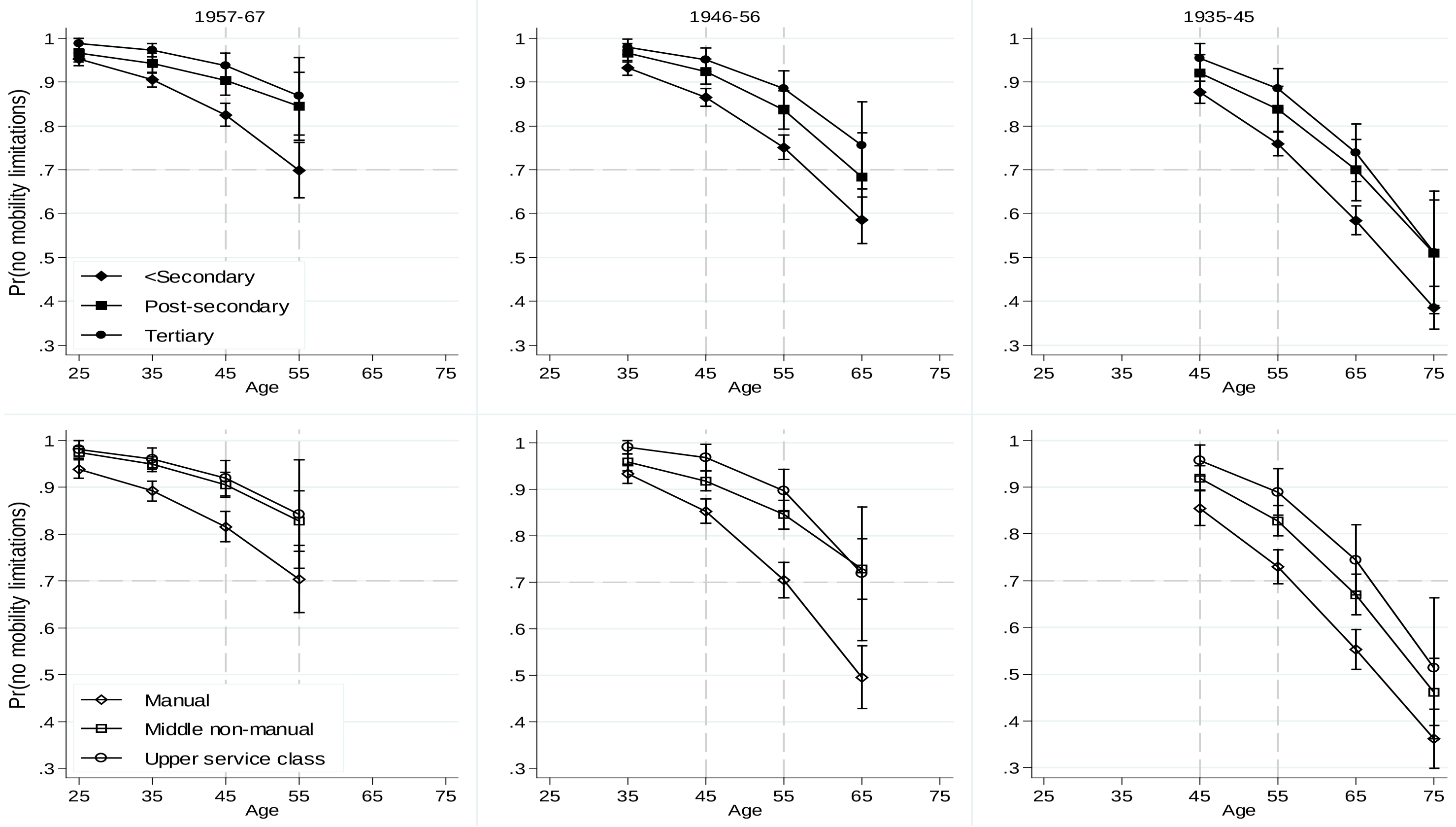

FIGURE A2
PROBABILITIES OF NO MOBILITY LIMITATIONS
BY AGE, EDUCATION, OCCUPATION, AND COHORT

Note: Swedish Level of Living Survey (1991–2010). Predictions for mobility limitations are based on models which are analogous to the models M1a – M1c. Marginal probabilities and confidence intervals are calculated for given values of age and educational group. All other covariates are set to their means.

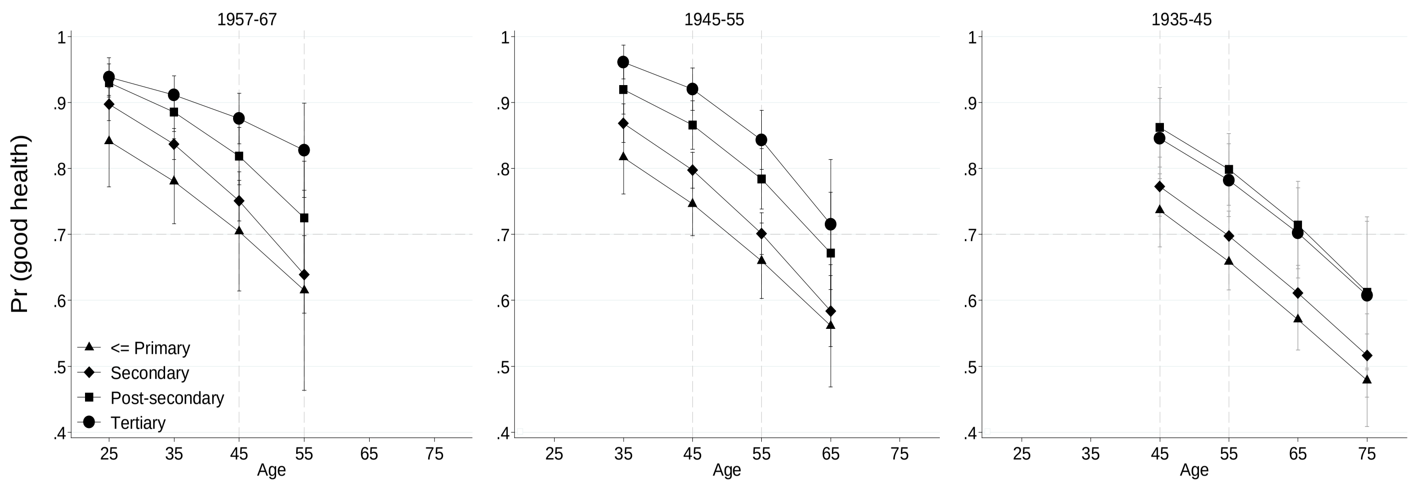

FIGURE A3: MARGINAL PROBABILITIES OF REPORTING GOOD HEALTH IN THREE COHORTS FOR FOUR EDUCATIONAL LEVELS

Note: Swedish Level of Living Survey (1991–2010). Predictions based on models, which are analogous to models M1a (1957-67), M1b (1946-56) and M1c (1935-45). Marginal probabilities are calculated for given values of age and education. Other covariates are set to their means.

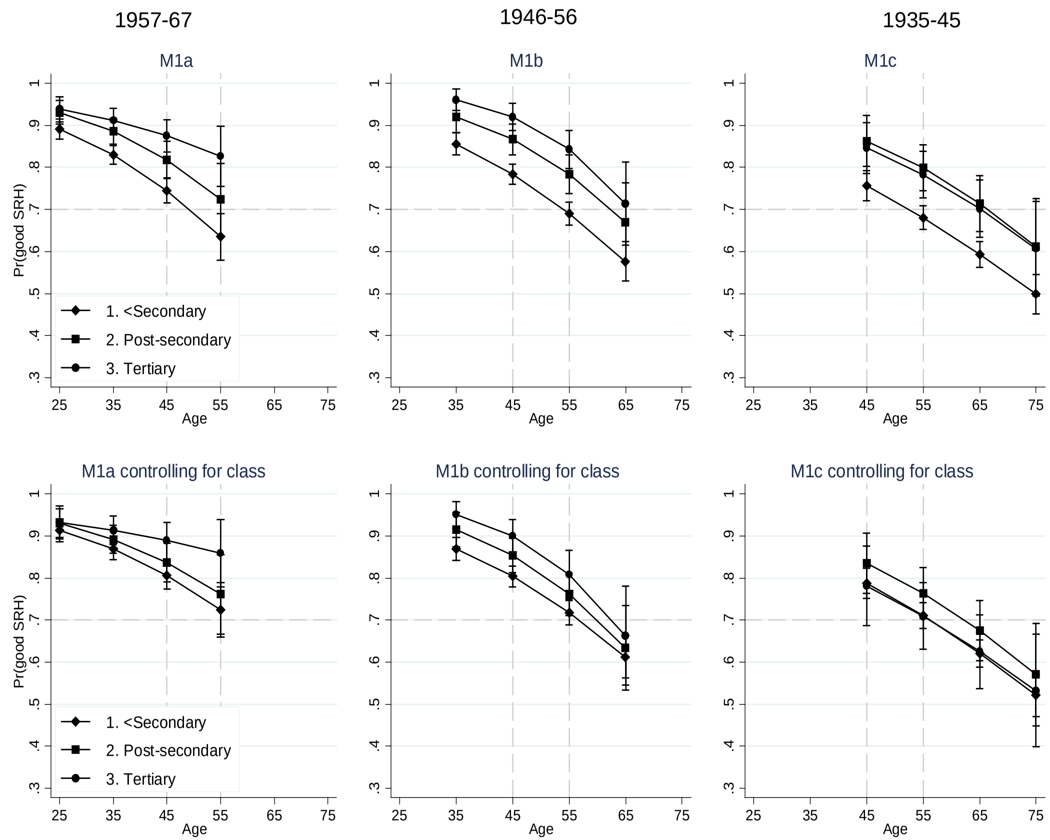

FIGURE A4

PROBABILITIES OF GOOD HEALTH BY AGE, EDUCATION, AND COHORT (UPPER PANEL)

AND

PROBABILITIES OF GOOD HEALTH BY AGE, EDUCATION, AND COHORT ADJUSTED FOR OCCUPATIONAL CLASS (BOTTOM PANEL)

Note: Swedish Level of Living Survey (1991–2010). Predictions shown in the upper panel are based on models M1a – M1c. Predictions shown in the bottom panel are based on models M1a-M1c adjusted for occupational class and for interactions between occupational class and age. Marginal probabilities and confidence intervals are calculated for given values of age and educational group. All other covariates are set to their means.

Appendix B: Statistical model

I estimated the population average (PA) logistic panel model (Liang and Zeger 1986). For the total sample, I estimated the following model:

$$logit\left(Pr\ (good\ health_{it}\ =\ 1)\right)$$
$$= \beta_0 + \beta_1\ age_{it} + \beta_2\ cohort_i + \beta_3\ SES_i + \beta_4\ age_{it} * cohort_i$$
$$+ \beta_5\ age_{it} * SES_i + \beta_6\ cohort_i * SES_i + \beta_7\ age_{it} * cohort_i * SES_i$$
$$+\ \beta_8\ controls_i$$

For the cohort-specific analysis, I estimated the following model separately for three cohorts:

$$logit\left(Pr\ (good\ health_{it}\ =\ 1)\right)$$
$$= \gamma_0 + \gamma_1\ age_{it} + \gamma_2\ SES_i\ + \gamma_3\ age_{it} * SES_i + \gamma_4\ controls_i$$

In these models, $logit\ (p) =\ log(p\ /\ (1 - p))$ is the logit link function for any probability of reporting good health. In the model for the total sample, the log-odds of reporting good health are estimated as a linear function of age, cohort, SES (either education or occupational class), twofold and threefold interactions between these variables, and controls. In the separate models for birth cohorts, the log-odds of reporting good health are estimated as a linear function of age, SES (either education or occupational class), interactions between age and SES, and controls.

I further modeled the following within-dependence correlation matrix:

$$R_{j,k} = \begin{cases} 1, & j = k \\ \rho_{jk}, & otherwise\ \ \rho_{jk}\ =\ \rho_{kj} \end{cases}$$

Here R_{jk} denotes the *j,k* element. This correlation structure is referred to as unstructured, given that it imposes only one constraint, namely that the diagonal elements of the matrix are 1, allowing a particular pair of residuals to be different from all other pairs. The unstructured correlation structure is a flexible way of modeling that is particularly recommended to use with few time points (Szmaragd et al. 2013).

Chapter III

Education and Health in the United States and Sweden: A Comparative View on Health Trajectories in Later Life

Abstract

The present study offers the first comparative investigation of the cumulative (dis)advantage hypothesis, which states that health disparities between educational groups increase with age. I focus on the United States and Sweden, two countries that offer sharp contrasts regarding social conditions that intensify or inhibit processes of cumulative (dis)advantage in health trajectories. The analysis is based on harmonized panel data from the Health and Retirement Study and the Survey of Health Ageing and Retirement in Europe, which include samples of educational groups that are similar in size, belong to the same birth cohorts, are observed across the same historical period, and report on the same health measures. I use hierarchical linear models to trace changes in chronic conditions among *N* = 9,385 individuals aged 50 to 74, comprising *N* = 38.612 panel observations. The analysis yields four central findings. First, health trajectories in both countries are consistent with the cumulative (dis)advantage hypothesis, as gaps between higher and lower educated individuals increase with age. Second, throughout the entire age range under study, educational disparities in health are much larger in the U.S. than in Sweden, suggesting that cumulative (dis)advantage hypothesis applies more strongly to this context. Third, cohort effects indicate that educational differences in health have intensified in the U.S., but not in Sweden. Fourth, across all ages and cohorts, I find a striking pattern of cross-national differences in education and health: Chronic conditions are most prevalent among lower educated Americans, followed by higher educated Americans, lower educated Swedes, and higher educated Swedes.

Introduction

Education is highly beneficial for health, and this positive effect gets larger with age (Ross and Mirowsky 2003). Research on health inequality has consistently shown that health gaps between higher and lower educated people increase over the life course (Dupre 2007; Kim 2008; Kim and Durden 2007; Lynch 2003; Mirowsky and Ross 2008; Willson et al. 2007). This evidence supports the cumulative (dis)advantage hypothesis, which states that education is associated with various kinds of health-related advantages that cumulate through life, enforcing a steady increase in health disparities (Ross and Wu 1996).

In recent years, tests of the cumulative (dis)advantage hypothesis have been refined by greater attention to the social conditions in which individual health trajectories unfold. An influential line of research demonstrating the importance of socio-historical context are cohort studies that have indicated a "rising importance" of the cumulative (dis)advantage process (Delaruelle et al. 2015; Goesling 2007; Kim 2008; Lynch 2003). According to these studies, more recent cohorts are increasingly exposed to contextual factors which intensify the cumulative advantages and disadvantages that education brings. These include rising inequality in economic returns to education, exposure to environmental stressors, and health knowledge and behaviors (Goesling 2007).

Although this line of research has offered compelling evidence for the context-specific nature of cumulative (dis)advantage, it remains largely limited to only one country context – the United States. This limitation is important, given that the inclusion of other country contexts could introduce variation in key institutional factors such as social policies that target inequalities in health. For example, cross-cohort differences within the United States are much smaller than cross-national differences between the United States and other countries when considering health-relevant policies such as social security, employment protection, unemployment benefits, health insurance, and access to health care (Avendano and Kawachi 2014). Consequently, a comparative view can shed more light on the importance of context for health inequality over the life course.

In view of that, I designed the present study to provide the first comparative investigation of the cumulative (dis)advantage hypothesis. In contrast to existing studies comparing health inequality in the U.S. to other developed societies, I use longitudinal data that allow me to disentangle age and cohort effects – a key interest of the studies on cumulative (dis)advantage (Lynch 2003). For the comparison, I focus on the United States and Sweden, two countries that offer particularly sharp contrasts with regard to the social conditions in which individual health trajectories unfold. Among developed societies, Sweden and the U.S. can be placed at opposite poles in terms of social policies targeting disparities in health-related resources. The U.S. provide favorable conditions for processes of cumulative (dis)advantage – lack of social security, unequal access to health care as well as large and growing social disparities in quality of living. Swedish social policy, in contrast, is designed to offset the forces of cumulative (dis)advantage (Avendano and Kawachi 2014). Sweden has long ranked among the most successful countries in minimizing inequality in educational opportunity, access to health care, working conditions, economic means and exposure to stress after adverse life events. If these policies are effective, I expect to observe large differences between the U.S. and Sweden both in (a) the magnitude of initial health gaps between educational groups and (b) in the rate of increase in these gaps over the life course.

I use U.S. panel data from the Health and Retirement Study (HRS) and Swedish panel data from the Survey of Health Ageing and Retirement in Europe (SHARE). These surveys are ideally suited for longitudinal comparisons because their data are highly similar in terms of sampling strategy, observation period, cohort range, and measures of education and health. Given that the sampling frames of HRS and SHARE include only middle-aged and older people, my analysis focuses on health trajectories in later life. My analytical samples include individuals aged 50 to 65 upon initial observation who are followed up biannually across an observation period of up to nine years between 2004 and 2013.

Theoretical Background

The cumulative (dis)advantage hypothesis describes a process by which initial relative advantages or disadvantages associated with a structural position generate a systematic divergence in life-course resources, opportunities, and risks (Dannefer 1987; Ferraro and Shippee 2009; Ferraro et al. 2009; O'Rand 1996). Applied to education and health, the cumulative (dis)advantage hypothesis posits that education structures advantages and disadvantages in all key determinates of health, producing widening health gaps between educational groups as people age (Ross and Wu 1996; Mirowsky and Ross 2008; Lynch 2003). Education reproduces and magnifies early advantages and disadvantages of social background and strongly determines income, occupational status and wealth in later life (Spring 1976; Kerckhoff 1995). Depending on social background, children grow up in stable or unstable families, attend better or worse schools, earn more or less, reach higher or lower occupational positions, and experience more or less of the "allostatic load" of stress associated with economic hardship, unemployment, and other negative life events (McEwen 1998).

Moreover, those who attain higher education increase their capacity of processing information and their sense of personal control (Ross and Mirowsky 2007) – skills that are essential for acquiring and maintaining a healthy life style. As a result, educational differences in a wide range of health behaviors including smoking, drinking, physical exercise and diet, emerge early and extend throughout the life course.

Although educational differences in these economic, work-related, and behavioral factors are less influential in earlier life, their effects accumulate over time (Ross and Wu 1996). Smokers and non-smokers, for example, are almost equally healthy in their twenties, but differences in functional limitations, chronic conditions, and diseases that are attributable to smoking gradually unfold in middle and later stages of the life course. The same applies to other health-related factors that are structured along educational lines. Because it takes years until adverse working conditions, economic hardship, and risky behaviors take their toll on health (Shuey and Willson 2014), the cumulative (dis)advantage hypothesis expects that educational gaps widen steadily with age.

The cumulative (dis)advantage hypothesis in comparative perspective

Current knowledge about the cumulative (dis)advantage hypothesis pertains primarily to the U.S. context. These findings cannot be simply generalized to other developed societies. A major reason for this, is that the degree to which education structures determinants of health, such as economic means, working conditions, exposure to stress, and health behaviors, depends on social policies regarding redistribution, protection against adverse working conditions, support after negative life events, interventions against risky health behaviors, quality of and access to health care, and so on (Bambra and Beckfield 2012; Beckfield et al. 2015).

In this regard, Sweden offers a sharp contrast to the U.S. (Avendano and Kawachi 2014; DiPrete 2002; Leopold 2016). In Table 1, I summarize differences between the U.S. and Sweden with respect to several key arguments on which the cumulative (dis)advantage hypothesis is based. As shown in the table, all of these arguments fit more closely with the U.S context than with the Swedish context (US > SE).

TABLE 1. CUMULATIVE (DIS)ADVANTAGE IN SWEDEN AND THE U.S.

	Argument	SE		US	Empirical evidence
Economic factors	Inequality in income		<		DiPrete 2002
	Inequality in poverty risk		<		Duncan et al. 1993
Working conditions	Inequality in the number of sickness or vacation days		<		Jorgensen 2002
	Inequality in employment protection		<		DiPrete 2002
	Inequality in unemployment benefits		<		Lundgren 2006; US Department of Labor 2016
Health behaviors	Inequality in smoking, physical activity, obesity		<		Power et al. 2005; Pierce 1989
Health care	Inequality in access		<		van der Wel et al. 2011

The comparison presented in Table 1 highlights differences in four groups of factors. First, among the lower educated, Swedes are better off economically than their U.S. counterparts. Economic policy in Sweden aims to compress pre-taxation wages and to redistribute through taxation. In this context, incomes are high and income inequality has long counted to among the lowest among developed societies. The U.S., in contrast, rank among the most unequal developed countries with regard to the distribution of income (OECD 2016a). Sweden and the U.S. are also at opposite poles regarding poverty risks. In 2012, the U.S. had the highest poverty rates among all OECD countries, with 21% of the older population and 17% of adult population living in poverty. This compares to only 9% in both groups in Sweden (OECD 2016b). Swedes are about four times less likely than Americans to enter poverty, and those who do are more likely to recover (DiPrete 2002). These differences suggest that the lower educated in Sweden are much less likely than lower educated in the U.S. to accumulate health disadvantages that are associated with economic hardship (Fritzell et al. 2013).

Second, Swedish labor market policy has a long tradition in reducing inequality in working conditions. This primarily concerns differences in employment protection. In Sweden, employers are encouraged to offer permanent full-time contracts. Most of Swedish employees remain in stable employment until the retirement age of 65 (Mayer 2005). Although lower educated Swedes are more likely to become unemployed (Korpi 2001), the social security system effectively compensates for the financial consequences of job loss. Unemployment benefits in Sweden range between 65 and 80 percent of pre-unemployment incomes and are paid over a period of 18 months after registering as unemployed. Those who remain in unemployment after this period are eligible for benefits that cover the minimum cost of living, including housing, food, clothing, and health care (Lundberg 2001). In the U.S., in contrast, unemployment benefits amount to only 40 to 50 percent of pre-unemployment incomes and are payed for a maximum of six months. After this period, no public support is offered to cover even the basic costs of living (U.S. Department of Labor 2016). In light of the large body of evidence on the health consequences of employment instability and unemployment (Jin et al. 1995), these contextual differences suggest that the lower educated in the U.S. are more vulnerable to processes of cumulative (dis)advantage than their Swedish counterparts.

Third, Swedes benefit from social policy measures that effectively reduce inequality in risky health behaviors. Although educational disparities in smoking, overweight, and obesity are still visible, their magnitude is rather low. Given that educational disparities in health behaviors constitute one of the main factors highlighted by the cumulative (dis)advantage hypothesis, this again suggests that health gaps grow less rapidly with age in Sweden compared to the United States.

Finally, universal access to high-quality health care and social security payments in case of disability may diminish the consequences of negative life events and serious illnesses (van der Wel et al. 2011). The Swedish welfare state provides necessary treatments and covers the costs for basic needs if individuals can no longer work because of sickness or disability. The Swedish welfare state guarantees this type of support regardless of age. Again, this policy context contrasts sharply with the U.S., where people are entitled to programs such as Medicare and Social Security only at older ages.

These four factors paint a clear-cut picture of differences between the U.S. and Sweden. Taken together, they suggest that the major forces behind the accumulation of advantages and disadvantages of education for health are less influential in the Swedish context than in the U.S. context. In other words, the accumulation of health-related advantages of higher education and health-related disadvantages of lower education is reinforced in the U.S. and inhibited in Sweden. Consequently, I hypothesize the following: *Compared to the U.S., educational health gaps in Sweden are smaller and widen less with age.*

Previous research in the U.S. and Sweden

Since the initial empirical investigation of the cumulative (dis)advantage hypothesis in research on education and health (Ross and Wu 1996), U.S. studies have gradually advanced our knowledge on how educational gaps in health unfold over the life course. The validity of the cumulative (dis)advantage hypothesis has long been contested. Doubts were raised in a number of studies that reported persistent or even narrowing health gaps between educational groups in older age (House 2005; Herd 2006). Other analyses showed that these patterns were found only in analyses that ignored cohort differences in the process of cumulative (dis)advantage (Lynch 2003, Mirowsky and Ross 2008).

The finding of narrowing health gaps emerged as an artifact in cross-sectional studies that could not disentangle age and cohort effects. In these studies, estimates on health inequality in older age were based on earlier cohorts, in which educational inequality in health was smaller than in more recent cohorts (Goesling 2007; Lynch 2003). Given that even in longitudinal studies, earlier cohorts are already approaching old age upon initial observation, a persistent pattern in older age is now commonly regarded as a result of preceding divergence (Mirowsky and Ross 2008, Kim 2008, Willson et al. 2007).

A further aspect that may profoundly influence the estimation of health trajectories in older age are selection effects related to health and education. Several studies have demonstrated that mortality and panel attrition are more pronounced among the lower educated (Lynch 2003, Noyemer 2001). These issues of selection have long been considered as a source of bias, but they are today increasingly acknowledged as a part of the cumulative (dis)advantage process itself: Those who have accumulated most disadvantages are also most likely to withdraw from surveys for health reasons or to die prematurely (Ferraro et al. 2009, Dupre 2007). Recent studies have recommended to complement tests of the cumulative (dis)advantage hypothesis by analyses on selective attrition and selective mortality (Rohwer 2016).

In summary, previous research has shown that studies on cumulative (dis)advantage of education for health across the life course should (a) use longitudinal data that allow the analyst to disentangle age and cohort effects, and (b) address the issues of selective attrition and mortality. Studies from the U.S. that fulfill these criteria have provided support for the cumulative (dis)advantage hypothesis, showing an increase of educational gaps in health across all stages of adulthood (Dupre 2007; Kim 2008; Kim and Durden 2007). Furthermore, this process was found to intensify across cohorts (Goesling 2007; Mirowsky and Ross 2008; Willson et al. 2007).

In Sweden, only one study has tested the cumulative (dis)advantage hypothesis (Leopold 2016). This study used longitudinal data covering two decades from 1990 until 2010. The results showed that educational gaps in self-rated health and mobility limitations widened until the mid-50s, but remained stable thereafter. Because selection processes are unlikely to operate at these ages, this study argued that the absence of further divergence could reflect the equalizing and compensatory role of the Swedish welfare state. Although this study's findings are partly in line with the hypothesized differences between Sweden and U.S., comparative conclusions remain vague, given that samples, observation periods, cohort ranges, and health measures differed from U.S. studies on cumulative (dis)advantage of education for health.

Studies that have directly compared the U.S. and Sweden have provided further evidence that is broadly consistent with the guiding hypothesis of the present study. Jürges (2010) has compared educational differences in chronic conditions and physical limitations among the population aged 50 and older in the U.S. and in 11 European countries including Sweden. The study showed that educational health inequality was largest in the U.S., whereas Sweden ranked among the least unequal countries. Avendano and colleagues (2010) found that educational inequality in mortality was highest in the U.S. and lowest in Sweden.

Although these studies offered more direct tests for cross-national differences in educational health inequality, they cannot answer the main question of the present study. Two limitations stand out. First, both studies compare educational groups of highly unequal size. For instance, in the study of Jürges, only 16% of the U.S. sample are classified as lower educated, compared to about 40% of Swedes. If the lower educated in the U.S. are not only a smaller group, but also a group that is more negatively selected on health, this may at least partially explain the cross-national differences found in these studies. Second, and even more importantly, both studies are based on cross-sectional data. As discussed earlier in this article, these data preclude an adequate empirical assessment of how educational gaps in health change with age. In view of these limitations, a comparative longitudinal design is necessary to test the guiding hypothesis of the present study.

Data and Method

Samples

I used harmonized longitudinal data from the U.S. Health and Retirement Study (HRS) for the U.S. and from the Survey of Health, Ageing and Retirement in Europe (SHARE) for Sweden. The SHARE has been developed with the explicit aim of providing European data that is nearly identical to the HRS (Börsch-Supan et al. 2013; Chien et al. 2014). Consequently, the sampling frames, the frequency of panel waves, and the measures of sociodemographic characteristics and health are highly comparable between these two datasets.

The target samples of both surveys applied to non-institutionalized individuals aged 50 years and older. Interviews were conducted over the phone in the U.S. and face-to-face in Sweden. I used data from five panel waves spanning the years between 2004 and 2012 in the U.S. and between 2004 and 2013 in Sweden.

I restricted both samples to individuals who (a) participated in the common baseline year of 2004 (see Willson et al. 2007) and (b) were aged 50 to 65 at this initial observation. Respondents from Sweden were recruited in 2004 – the starting year of the SHARE – whereas respondents from the U.S. were partly recruited earlier, as the collection of HRS data started already in 1992. In the year 2004, however, the HRS sample was refreshed in order to represent the U.S. population aged 50 years and older. Consequently, both samples were highly comparable in the baseline year used for the present study.

I excluded immigrants from the analysis, because their educational degrees are not equivalent to the educational degrees of respondents from the host countries. Moreover, immigrants constitute a groups that is positively selected on health, so that the standard arguments behind the cumulative (dis)advantage thesis do not fully apply to this group (Markides and Eschbach 2005). After all restrictions, the analytical sample for the U.S. consisted of 7,836 individuals comprising 34,322 panel observations; the analytical sample for Sweden consisted of 1,549 individuals comprising

4,298 panel observations. In Table 2 I describe both samples on key measures used for the analysis. For the multivariate models, I pooled both samples into one dataset consisting of 9,385 individuals and 38,612 panel observations.

TABLE 2: DESCRIPTIVE STATISTICS

	US				SE			
	Mean / %	SD	Min	Max	Mean / %	SD	Min	Max
Age and Cohort								
Age	62	5.40	50	73	62	5.49	50	74
Year of birth	1946	4.62	1939	1954	1946	4.36	1939	1954
Age at first wave	58	4.62	50	65	58	4.36	50	65
Education								
Lower	49%				43%			
Intermediate	26%				30%			
Higher	25%				27%			
Health measures								
Number of chronic conditions	.99	.94	0	5	.49	.70	0	5
High blood pressure	53%				29%			
Diabetes	19%				10%			
Controls								
Male	42%				46%			
Died	7.5%				1.6%			
Dropped out	20%				44%			
Number of individuals	7,836				1,549			
Number of observations	34,322				4,298			

Note: HRS, release 2014, SHARE, release 2015.

Measures of Health

For the purposes of my study, the health measures had to satisfy two main criteria. First, given the comparative design of my study, the health measures had to be comparable across both datasets. This criterion was met by three measures, self-rated health, functional limitations, and chronic conditions. Second, as my samples consisted of older adults, the health measures had to be sensitive towards changes in health in later life. As research has indicated, self-rated health is limited regarding the second criterion. Functional limitations and chronic conditions, in contrast, are considered to adequately capture health declines in older age (Deaton and Paxson 1998).

From these measures, I selected chronic conditions as my main measure of health. It includes conditions such as high blood pressure, diabetes, stroke, cancer, and lung disease. For the purposes of this study, the measure of chronic conditions has three benefits. First, except for some types of cancer, individuals tend to be at a higher or lower risk of being diagnosed with one or more of these conditions depending on their long-term lifestyles and exposure to various health stressors (Sturm 2002). Second, the measure of chronic conditions does not rely on respondents' self-assessment. Instead, identical survey questions in HRS and SHARE asked the respondents to report only conditions that were diagnosed by a doctor. Self-assessed measures such as functional limitations, in contrast, rely more strongly on cognitive skills that are unequally distributed between educational groups (Zajacova and Dowd 2011). Third, the measure of chronic conditions that were diagnosed by a doctor is unlikely to be affected by cultural bias – an important issue in comparative studies of health inequality. As the quality of medical care is high in both Sweden and the U.S., there are no reasons for assuming systematic differences in the chance of getting the right diagnoses. Self-assessed measures, in contrast, may reflect cultural differences in the evaluation of what constitutes a limitation in performing certain activities or from when on health is considered poor (Jürges 2007).

The only potential issue regarding comparability in a measure of chronic conditions concerns differences in access to health care. Because lower educated people in the U.S. face higher costs for seeing a doctor than their Swedish counterparts, they might receive fewer diagnoses. Research from the U.S. suggests, however, that this type of bias is minor. Studies have shown that people prioritize health expenditures and still visit the doctor even if they have difficulties in making ends meet (Ross and Mirowsky 2000).

I assessed chronic conditions in two ways. First, I constructed an additive index taking values from 0 (no chronic conditions) to 5 (five chronic conditions). Such indices are suitable for a test of cumulative (dis)advantage in health, as they indicate the rate of accumulating health problems with age (Sturm 2002). Yet, critics have argued that a simple additive approach does not adequately reflect the nature of health decline. An additive index, for example, assigns the same values to people diagnosed with high blood pressure and diabetes and to people diagnosed with cancer and stroke. In line with previous research (Avendano et al. 2009), I addressed this limitation by additionally analyzing the probability of reporting two specific chronic conditions that were most prevalent in both countries – high blood pressure (53% in the U.S. and 29% in Sweden) and diabetes (19% in the U.S. and 10% in Sweden). I measured these conditions by indicator variables equaling 1 if a respondent reported being diagnosed with the condition and 0 otherwise.

Data on health have been collected in each of the five HRS waves used for the U.S. and in four of the five SHARE waves used for Sweden. In Sweden, detailed questions on health were excluded in the third wave (2009), which focused on collecting extensive retrospective data. Because this information on chronic conditions is missing completely at random (i.e., by design of the questionnaire) and because detailed data about health have been collected in two subsequent waves, these missing data are unlikely to affect the comparability of the results.

As visible from Table 2, the U.S. and Sweden differ strongly regarding average health levels. In each of the measures, health problems among older adults in the U.S. are about twice as prevalent as in Sweden. These results are in line with a large body of cross-national comparative research showing that among all developed western societies, the U.S. are worst off regarding average health levels, life expectancy and mortality, whereas Sweden's population ranks among the healthiest and longest-living (Avendano and Kawachi 2014).

Education

I used a categorical approach to measure *education*, drawing on information about a respondent's highest level of education collected upon first observation in 2004. I distinguished between lower, intermediate and higher education. The bottom category of lower education included respondents with primary education, lower secondary education, and high school dropouts; the middle category of intermediate education consisted of those holding upper secondary education or post-secondary vocational degrees; the top category of higher education included those who had attained a BA degree or higher levels of tertiary education.

I specified this scheme of three educational groups to satisfy two analytical requirements for the comparative aims of my study. First, these categories represent comparable groups regarding their substantive levels of education. Although the U.S. and Sweden differ in the degree to which the quality of education is standardized and in returns to education (Pfeffer 2008), formal structural features of educational systems and their connection with the labor market are similar (Mayer 2005). Specifically, education in both the U.S. and Sweden can be characterized as inclusive and general than stratifying and specialized, given that tracking is late and connection between education and particular occupations is loose (DiPrete 2002).

Second, these categories also represent groups that are of comparable size in both countries. This benefit is important to addressed one shortcoming of previous comparative research – namely that the lower educated in the U.S. constituted a smaller and presumably more negatively selected group. As shown in Table 2, educational groups in the U.S. and Sweden were of similar size in the present study. Moreover, the lower educated constituted the largest group, which was even 6 percentage points larger in the U.S. than in Sweden. Based on this categorical scheme of education, negative selection of lower educated people can be considered a less influential driver of potential differences between both societies.

In addition, I examined whether the size of educational groups in the U.S. and Sweden had changed in a similar fashion across cohorts. If the group of lower educated would shrink faster in the U.S. than in Sweden (e.g., due to differential rates of educational expansion), cumulative (dis)advantage might intensify among recent cohorts of Americans because the lower educated would represent an increasingly negative selection from the population. Figure 1 shows that the risk of such bias in my data was low, as educational expansion was similar across the study cohorts in both countries.

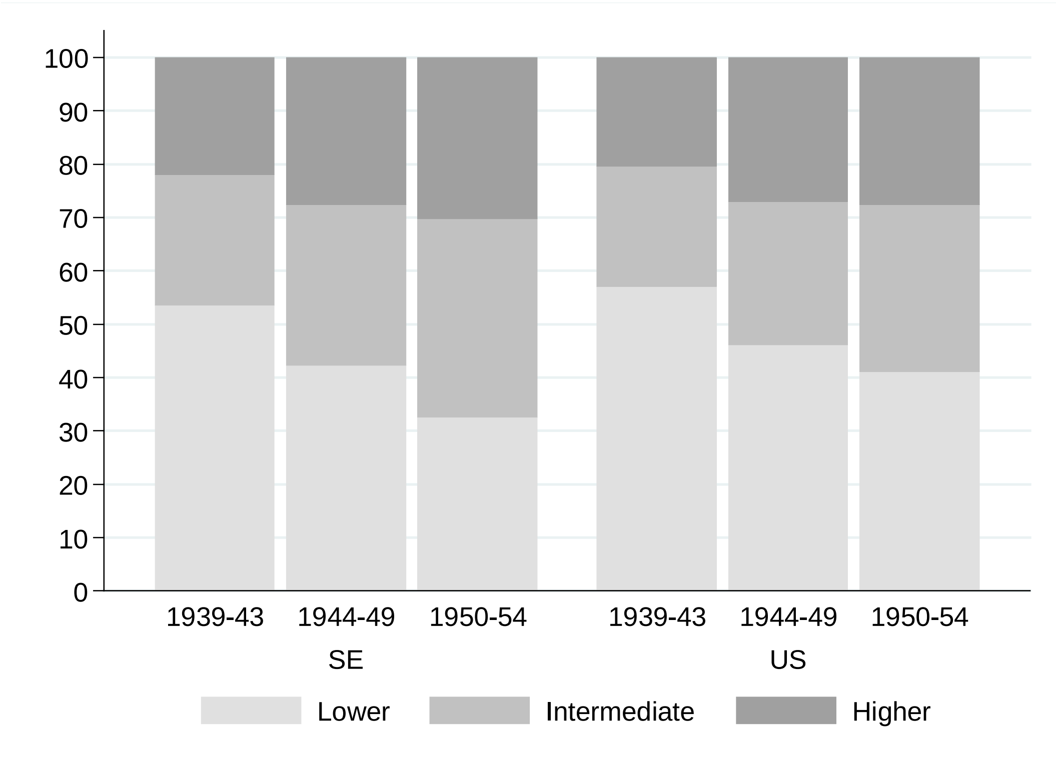

FIGURE 1: DISTRIBUTION OF EDUCATIONAL LEVELS ACROSS COHORTS IN SWEDEN AND IN THE US
Note: HRS, release 2014; SHARE, release 2015.

Age and Cohort

Age was measured in years, ranging from 50 to 73 in the U.S. and from 50 to 74 in Sweden. I also included a quadratic term of age to account for possibly non-linear age trajectories. The respondents' birth years ranged from 1939 to 1954 in both countries. Similar to other studies on cumulative (dis)advantage (Mirowsky and Ross 2008, Willson et al. 2007), I included birth cohort in the models as a linear term representing age at first observation, centered at the minimum age of 50.

Controls

Because men and women differ in their average health levels and in their rates of health decline, I used controls for gender and an interaction between gender and age. In addition, I controlled for interactions between gender and cohort and for a three-fold interaction between gender, age and cohort. These controls accounted for the effects of changes in gender composition across cohorts (as men die earlier). According to the BIC criterion, this model provided the best fit to the data.

In additional analyses, I also assessed whether educational differences in health trajectories differed for men and women in the U.S and in Sweden, introducing interactions between education, gender, age, cohort, and country. In both countries, I found that educational differences were slightly more pronounced among women. These patterns are consistent with previous research in both countries (Ross and Mirowsky 2005, Leopold 2016). Because the general patterns were similar for men and women in both countries and because of the limited case numbers available in the Swedish sample, I did not include these interactions in my main analysis.

Previous U.S. studies have controlled for racial and regional differences in health (Willson et al. 2007; Herd 2006). In additional analyses, I examined whether such differences in the U.S. influenced my findings on cross-country differences compared to Sweden. In line with the previous research, overall health levels in the U.S. moved closer to Swedish levels after introducing these controls. However, this convergence was small and did not alter my conclusions. For this reason, I kept the model parsimonious and did not include these controls in the analysis presented below.

To address the issue of non-random dropout associated with poor health, I applied the method suggested by Chen, Yang, and Liu (2010), introducing controls for panel attrition. I constructed two time-constant indicator variables for whether respondents (a) had left the panel or (b) had died before the most recent wave of 2012 in the U.S. and of 2013 in Sweden.

As shown in Table 2, the samples from the U.S. and Sweden differed strongly regarding the proportion of deaths and dropouts. While 7.5% of respondents in the U.S. sample died between 2004 and 2012, only 1.6% of respondents in the Swedish sample died. These differences reflect both the generally higher mortality rates in the U.S. (Avendano et al. 2009) and the recent rise in longevity among older people in Sweden (Johansson et al. 2015). A reverse picture emerged with regard to dropout from the panel. Only 20% of respondents from the U.S. sample of the HRS dropped out before the most recent wave, compared to 44% of respondents from the Swedish sample of the SHARE. These differential rates of attrition might emerge from (a) differences in the form of the interview (telephone interviews in the U.S., personal interviews in Sweden), and (b) cultural differences, as high participation rates are typical for the U.S.

For the purposes of my study, it was important to address these differences as a potential source of bias. Results would be biased, for example, if lower educated Swedes dropped out due to poor health. This type of selective dropout could result in misleading findings of educational health gaps that are small and do not increase with age. To examine this possibility, I conducted additional analyses in which I assessed country differences in (a) dropout risk among the lower educated, and (b) initial health levels and subsequent trajectories of health decline among lower educated dropouts compared to those who stayed in the panel (see Results section for details).

Analytic strategy

I used hierarchical linear models (HLM) to estimate change in the main outcomes measure – the number of chronic conditions – and hierarchical linear probability models to estimate change in the risk of high blood pressure and diabetes. In additional analyses (not shown), I addressed right-skew in the distribution of the number of chronic conditions by adding one and then taking the natural logarithm. This transformation did not affect the results. Therefore, I used the untransformed variable in the estimation.

My data included up to five observations per person in the U.S (2004, 2006, 2008, 2010 and 2012) and up to four observations in Sweden (2004, 2007, 2011 and 2013). These repeated observations (level 1) were nested within persons (level 2). The HLM estimation accounts for heterogeneity in health trajectories, allowing individual trajectories to differ in their starting levels (random intercepts) and rates of change (random slopes). The estimation of HLM provided information about mean health trajectories (growth curves) as well as individual variation around the average curves.

An appropriate analytical strategy to estimate change in the relationship between education and health is to account simultaneously for change with age, change across cohorts, and their interactions (Lynch 2003, Willson et al. 2007, Mirowsky and Ross 2008). This approach translates into an empirical model that includes age, cohort, and education as well as two-fold and three-fold interactions between these variables. Because a key interest was in cross-country differences in these interactions, I interacted all model variables (including controls) with an indicator variable for country (U.S. vs. Sweden).

All results from the multivariate models are shown in Table A1 in the Appendix. In the presence of multiple three-fold and four-fold interactions, the interpretation of coefficients in Table A1 is not straightforward. The main effect of age, for example, pertains to lower educated Swedish women in the youngest cohort. In order to provide a fuller picture, I rely on graphical analyses derived from the model estimates. In Figure 2, I present my main results for the number of chronic conditions. In Figure A1 in the Appendix I present additional results for the probability of high blood pressure (left-hand plot) and the probability of diabetes (right-hand plot).

Results

The findings presented in Figure 2 provide answers to the main research questions of the present study, namely (a) whether educational gaps health are larger in the U.S. than in Sweden and (b) whether they widen more strongly with age.

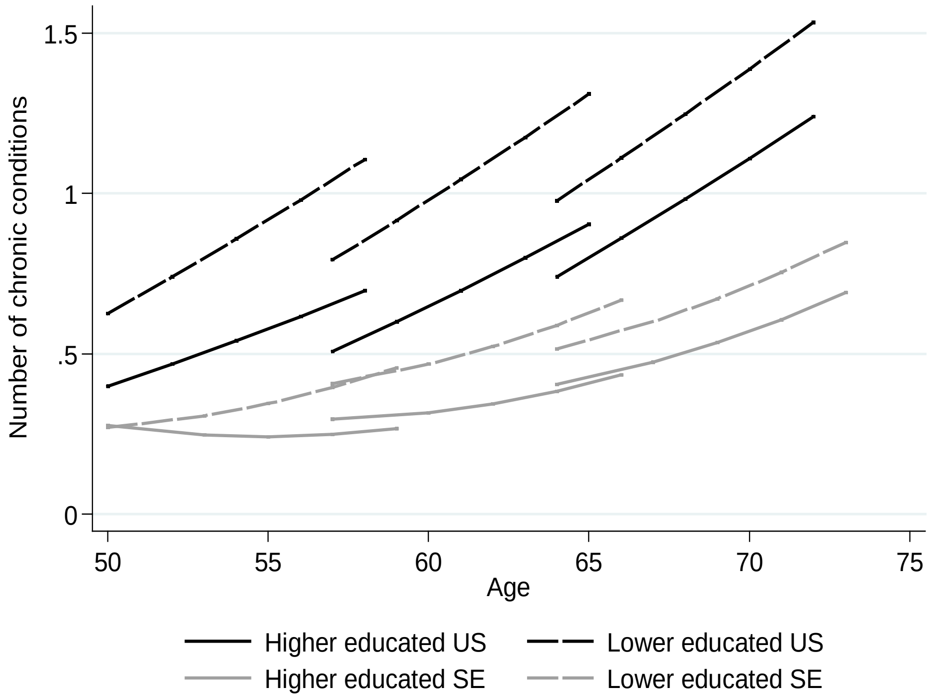

FIGURE 2: PREDICTED AGING VECTORS OF CHRONIC CONDITIONS BY EDUCATION AND COUNTRY

Note: HRS, release 2014; SHARE, release 2015; predictions are based on the estimates from Model 1, Table A1.

The results are presented in the form of age-vector graphs (Mirowsky and Kim 2007). These graphs show model-based predictions for initial health levels and for change in health among the higher educated, indicated by solid lines, and among the lower educated, indicated by dashed lines. Black curves pertain to the U.S., grey curves to Sweden. For each educational group in each country, To account for cohort effects I fixed the variable for cohort at three values corresponding to the birth years of 1940, 1947, and 1954. All other variables are fixed at their means. The *y*-axis indicates predicted levels of health, whereby higher values indicate worse health (i.e., an increasing number of chronic conditions).

The *x*-axis shows each cohort's age at the beginning and at the end of the observation period. The youngest cohort, for example, was aged 50 at the start of the observation period in 2004 (i.e., birth cohort of 1954) and approached age 60 by the end of the observation period. An important advantage of the graphical age-vector analysis is that it not only allows to identify educational gaps in age trajectories of health, but also cohort differences in these trajectories (Mirowsky and Kim 2007). The age overlap between subsequent cohorts provides an indication for cohort effects: if cohort effects are small, the cohort-specific curves connect; if cohort effects get larger, the pattern appears increasingly ragged.

Three central findings emerged from the analysis. First, in line with the previous research I found a strong cross-national gradient in health. In the U.S., both the higher and the lower educated suffered from more chronic conditions than their Swedish counterparts. This applied in all cohorts and throughout the age range studied. The magnitude of these differences is striking. As shown in Figure 2, the curves of both educational groups from the U.S. are located clearly above both curves for Sweden. This means that *lower* educated Swedes were in better health than *higher* educated Americans. Figure A1 in the Appendix shows the same pattern for two specific chronic conditions, high blood pressure and diabetes. In an additional sensitivity analysis, I found the same pattern in the number of functional limitations.

Second, the Figure 1 shows clear differences between the U.S. and Sweden with regard to cohort effects. In the U.S., the curves are ragged, whereas they tend to connect to a single curve in

Sweden. In the U.S., more recent cohorts are in increasingly worse health when observed at the same ages in the panel. This pertains particularly to the lower educated, but also to higher educated Americans.

Third, as expected, educational health gaps were larger in the U.S. than in Sweden. These differences emerged most clearly at younger ages and among more recent cohorts. For example, at the initial age of 50, the estimates for Sweden show hardly any educational differences in the number of chronic conditions. In the U.S., in contrast, educational differences amounted to approximately 0.3 conditions, a gap that is equivalent to one standard deviation in this sample. As the youngest cohort moved through their 50s, the gaps increased to 0.6 in the U.S. and to 0.2 in Sweden. These findings support the cumulative (dis)advantage hypothesis in both countries. This empirical support pertains to more recent cohorts and to an age range between the early 50s and mid-60s, after which the observation windows for younger cohorts is censored.

Figure 3 provides an additional visualization of the results on cumulative (dis)advantage. It shows predicted differences between the higher educated (reference line) and the lower educated in the U.S. and in Sweden. Cohort is fixed at the most recent value (i.e., birth cohort of 1954) for this prediction because younger cohorts are less likely to be affected by selection bias in terms of survey entry and exit. The figure shows 95% confidence intervals to assess statistical significance. I extrapolate the estimation for the age range between 50 and 70 to illustrate how educational gaps in chronic conditions are predicted to develop in this group, assuming that the education-specific rates of increase in the number of chronic conditions remain constant.

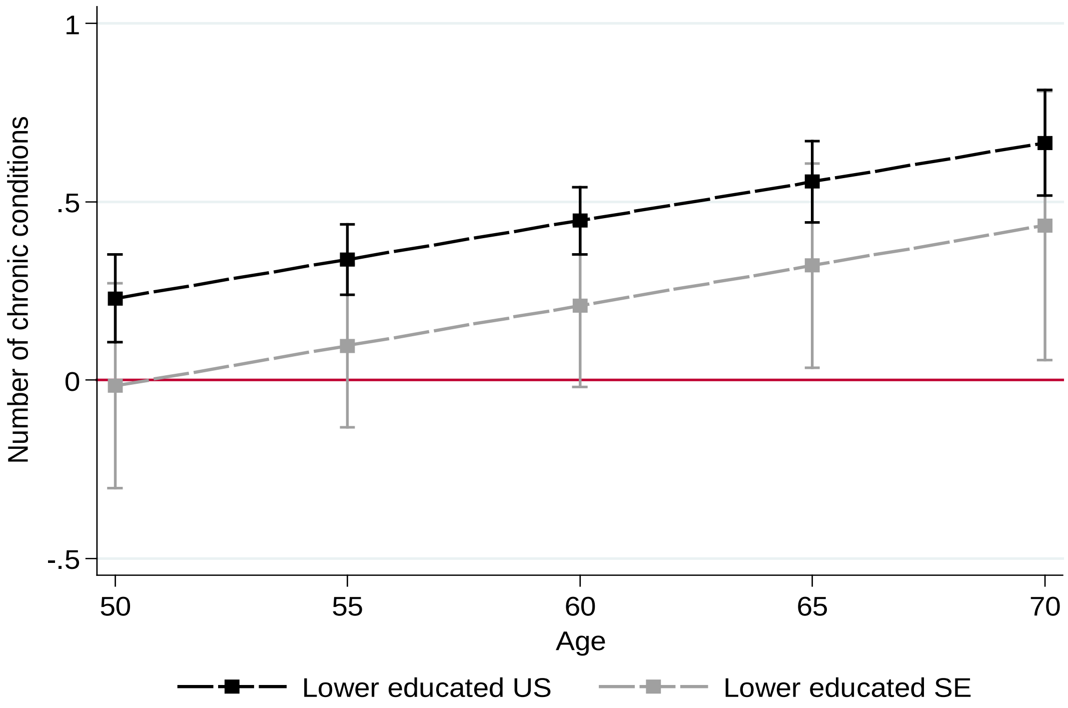

FIGURE 3: PREDICTED DIFFERENCES IN THE NUMBER OF CHRONIC CONDITIONS BETWEEN LOWER AND HIGHER EDUCATED BY COUNTRY

Note: HRS, release 2014; SHARE, release 2015; predictions are based on the estimates from Model 1, Table A1.

Figure 3 shows that educational gaps in the number of chronic conditions increase in both countries. The pattern of divergence is statistically significant in both countries, as indicated the confidence intervals and their overlap with the reference line pertaining to the health levels of the higher educated. The curve for the U.S. is located above the curve for Sweden, indicating larger educational health gaps at the initial age. Yet the slopes are similar, indicating comparable increase in these gaps until the age of 70.

These educational health trajectories are consistent with the cumulative (dis)advantage hypothesis in both countries. Furthermore, the rate of divergence of educational gaps within the observation window is similar between the two countries. However, it is important to note that this divergence (a) started from very different levels of health at initial observation, and (b) resulted in considerably larger educational health gaps in the U.S. compared to Sweden.

Attrition analysis

To assess the robustness of my findings, I conducted attrition analyses with a particular focus on differences between the U.S. and Sweden with respect to dropouts from the panel. As shown in Table 2, the share of dropouts in the Swedish data from the SHARE is more than twice as large as in the U.S. data from the HRS. If these dropouts are related to education and health, differential attrition may bias the comparative results.

I examine this possible source of bias in Table 3 and in Figure 4. Table 3 shows three columns separately by country and level of education (higher or lower). The left-hand column ("stayed") pertains to those who remained under observation from the initial wave of 2004 until the last wave; the middle column ("left") pertains to those who left the panel before the last wave; the right-hand column ("died") pertains to those who died before the last wave. The descriptive statistics show (a) how the prevalence of attrition differed by country and education, and (b) how health at initial observation (measured by number of chronic conditions) was associated with subsequent attrition from the panel.

Two findings from Table 3 speak to attrition as a possible source of bias for my substantive findings. First, the lower educated were more likely to die in both countries, although such occurrences were rare in Sweden. In line with previous evidence, this suggests that selective mortality leads to positive selection effects with regard to health among the lower educated who remain under observation (Beckett 2000). This is further corroborated by the findings on average levels of health at initial observation, showing that those who died suffered from more chronic conditions already in the baseline year of 2004. Given that positive selection effects related to "healthy survivors" pertained more strongly to the U.S. than to Sweden, these findings suggest that my estimates on better health among lower educated Swedes are conservative.

Second, although dropout for reasons other than death was more prevalent and more stratified by education in Sweden than in the U.S., these differences in panel attrition were unrelated to health upon initial observation. As indicated by the average number of chronic conditions, baseline health in both countries and educational groups did not differ substantially among those who left the panel and those who stayed.

Although the findings from Table 3 increase confidence in the results presented above, they do not answer a further question, namely whether *changes* in health were related to different types of attrition. If Swedes who left the panel had steeper health declines before dropping out, for example, this might still bias my comparative findings even if initial levels of health were unrelated to panel attrition. In Figure 4, I assess this possible source of bias. The curves shown in the figure are based on models in which I interacted an indicator variable for dropout ("left" compared to "stayed") with age, cohort, education, and country. The health trajectories for people who dropped out are extrapolated until the end of the observation period by carrying forward their health trajectories observed before dropping out. In line with the selective attrition argument (Lynch 2003), the results did not show a relationship between dropping out and preceding health trajectories among higher educated people. Therefore, I only visualize the estimated health trajectories for lower educated people in the U.S. and Sweden.

TABLE 3: ATTRITION ANALYSIS

	SE						US					
	Low education			High education			Low education			High education		
	Stayed	Dropped out	Died	Stayed	Dropped out	Died	Stayed	Dropped out	Died	Stayed	Dropped out	Died
% of initial sample	49.8	47.8	2.4	64.6	35.2	0.24	77.9	12.9	9.3	82.2	13.1	4.72
Number of chronic conditions at Wave 1	0.444	0.426	1.000	0.331	0.297	2.000	0.840	0.804	1.638	0.527	0.593	1.281
Number of individuals	333	319	16	266	145	1	2987	493	356	1584	252	91
Number of observations	1451	667	35	1187	303	4	14440	1415	726	7759	702	198

Note: HRS, release 2014, SHARE, release 2015.

The figure shows that except for the earliest cohort health trajectories of lower educated people were unrelated to dropout status in Sweden. In the earliest cohort, the average number of chronic conditions but not the rate of increase in chronic conditions was higher among dropouts compared to those who stayed in the panel. In the U.S., each cohort of lower educated people who dropped out of the sample experienced higher initial levels and steeper increases in the number of chronic conditions compared to those who remained under observation. These findings show that although panel attrition was more prevalent in the Swedish data, health-related was considerably more prevalent in the U.S. Taken together, these additional analyses suggest that my main results on cross-country differences in baseline health and health trajectories, as well as educational gradients therein, are robust to differential rates of attrition.

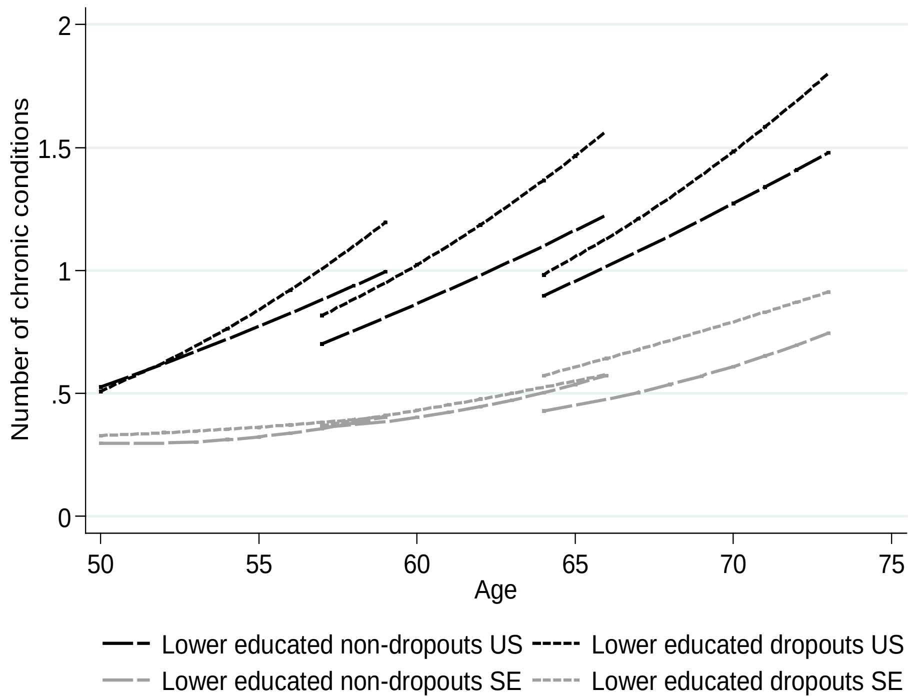

FIGURE 4: PREDICTED NUMBER OF CHRONIC CONDITIONS AMONG LOWER EDUCATED BY DROPOUT STATUS AND COUNTRY

Note: HRS, release 2014; SHARE, release 2015; predictions are based on the estimates from Model 1, Table A1.

Discussion

According to the cumulative (dis)advantage hypothesis, education reproduces and magnifies differences in health-related resources over the life course, leading to growing educational gaps in health from younger age to older age (Ross and Wu 1996). Recent studies on this hypothesis have shown that the degree to which higher or lower education brings cumulative advantages or disadvantages for health strongly depends on the social conditions in which individual health trajectories unfold. Although the context-specific nature of these phenomena are increasingly recognized, rigorous empirical tests of the cumulative (dis)advantage hypothesis remain almost entirely limited to the U.S. context.

The present investigation addressed this gap of knowledge. Using cross-national comparative data from the HRS and the SHARE, I examined educational gaps in health trajectories of older people in the U.S. and Sweden. This comparison is of particular interest to research on health inequality because Sweden and the U.S. contrast sharply with respect to social policies aiming to reduce inequality in health-related resources and risks over the life course (DiPrete 2002). Whereas social policy in the U.S. does not target the forces of cumulative (dis)advantage, Sweden has earned a reputation of effectively fighting inequality in all key determinants of health. These differences motivated the guiding hypothesis of the present study, which stated that educational health gaps in Sweden are smaller and widen less with age.

Three main results emerged from this analysis. First, I found large differences between the U.S. and Sweden in the extent to which education shapes health trajectories in older age. My findings support the cumulative (dis)advantage hypothesis in both countries, but the cross-national comparison revealed much larger educational differences in chronic conditions among U.S. people already at the age of 50. Although I could not examine previous life course stages in which these gaps opened up, this result in consistent with previous research that has examined education and health across younger ages (Mirowsky and Ross 2008; Leopold 2016). Although throughout the observation period, educational gaps in health remained much larger in the U.S. than in Sweden. In both countries these gaps widened particularly in more recent cohorts, which were observed until their early-to-mid-60s. In earlier cohorts, which were observed until ages of 70 and older, health gaps between educational groups remained constant in both countries.

In contrast to previous comparative studies of Sweden and the U.S., these findings are based on a longitudinal research design and highly comparable measures for education and health. Furthermore, unlike previous comparative research on health inequality, these findings are further corroborated by attrition analyses that ruled out selective dropout as an explanation for smaller educational health gaps found in Sweden.

Second, I found notable cross-country differences in the extent to which educational health trajectories were shaped by cohort effects. In the U.S., cohort effects were strong. Consistent with other studies (Goesling 2007, Mirowsky and Ross 2008) my results indicated a "rising importance" of cumulative (dis)advantage, as the pattern of divergence intensified across cohorts. In Sweden, cohort effects were negligible. In contrast to previous comparative studies of health inequality that were based on cross-sectional designs (Jürges 2010, Avendano at al. 2010), my longitudinal data allowed me to uncover such differences by disentangling age and cohort effects on health.

The differences found between the U.S. and Sweden in the size of cohort effects are broadly in line with substantive arguments about country differences in the socio-historical conditions surrounding successive birth cohorts. In the U.S, the finding of increasing cumulative (dis)advantage has been attributed to a sharp and steady increase in economic inequality since the 1970s and, more recently, also in socioeconomic disparities in risky health behaviors (Mirowsky and Ross 2008; Hayward et al. 2015). In Sweden, inequality in these health-related resources has increased only slightly across cohorts. Although the Swedish welfare state has witnessed cutbacks since the 1990s and social security, health care, and the labor market have become more liberal (Freeman et al. 2010; Fritzell and Lundberg 2007) – shifts that might favor processes of cumulative (dis)advantage – the magnitude of these changes is not comparable to the trends found in the United States (Bambra and Beckfield 2012). Moreover, my study cohorts still enjoyed the golden age of the Swedish welfare state (Esping-Andersen 1999) throughout major stages of their lives and were less affected by the severe economic crisis of the 1990s.

The third and perhaps most striking result of the present study concerns cross-national differences in older people's health found across all educational groups. Most notably, across the entire life course period that I examined, the following rank order emerged: Higher educated Swedes were in best health, followed by lower educated Swedes, higher educated Americans, and lower educated Americans. In other words, despite their large health advantage over lower educated Americans, higher-educated Americans were still in worse health not only compared even to lower educated Swedes. Confidence in this finding is strengthened by specific analytical benefits of the present study, which compared educational groups that belonged to the same birth cohorts, were observed in the same historical period, reported on the same health measures, were comparable in size in both countries, and were not affected by compositional change related to differential rates of attrition.

Moreover, this finding is consistent with the studies by Avendano and colleagues (2009, 2010), who find substantial disadvantages in terms of life expectancy, chronic conditions and functional limitations among wealthy and higher educated Americans as compared to Europeans. Similarly, Banks and colleagues (2006) found that rates of self-reported hypertension, diabetes and of a wide range of biological measures among Americans belonging to the top third of the income distribution were comparable to those found in the bottom third of the income distribution in England. Similar to my results, Banks and colleagues found that these striking differences were not driven by compositional effects with respect to race or region.

The present study adds to these findings by showing that the health disadvantage of lower and higher educated Americans as compared to their Swedish counterparts did not level off with age or across cohorts. Explanations that have been advanced for these remarkable patterns are societal factors that expose not only disadvantaged Americans but also privileged Americans to more adverse living conditions and higher levels of stress. These include the smoking and obesity epidemics as well as upstream social policy regarding infrastructure, employment protection, housing, family, and health care (Avendano and Kawachi 2014). In view of the current study's results, it appears worthwhile to examine the mechanisms underlying the prevalence of health problems among higher educated Americans in more detail.

The present study extends our knowledge on the importance of context for cumulative (dis)advantage in health. By situating key arguments behind this hypothesis in comparative perspective, my findings speak to a guiding hypothesis about two national contexts that intensify or inhibit processes of cumulative (dis)advantage. Although educational gaps in health widened with age in both countries, the differences in the size of these gaps clearly revealed that cumulative (dis)advantage applied more strongly in the U.S. than in Sweden. In this sense, my findings provide initial comparative insight into the context-specific nature of cumulative advantages and disadvantages of education for health.

On a more general level, this study's findings add to knowledge on cross-national differences in educational disparities in health. Because previous comparative research on the U.S. and Sweden was based on cross-sectional data, it did not provide insight into life-course and cohort-specific processes that produce these gaps. This limitation is particularly important when considering current evidence on the “nordic health paradox,” which suggests that health inequality is larger in egalitarian countries such as Sweden (Eikemo et al. 2008, Mackenbach 2012). Longitudinal analyses from a cumulative (dis)advantage perspective will allow to identify to what extent these comparative findings are influenced by country differences in age and cohort patterns as well as country differences in selective attrition and mortality.

Although it was beyond the scope of the current study to address the institutional mechanisms behind cross-national differences in health trajectories, the results support the general idea that cumulative (dis)advantage in health is responsive to contextual factors. I have focused on two societies that offer a sharp contrast regarding these factors. Future research could extend the comparative scope to include more societies. Comparable longitudinal data is available in SHARE and ELSA for further countries, including other Scandinavian welfare states, Central and Southern European countries, and the United Kingdom. Adding these countries to the analysis will introduce more variation in the contextual factors shaping health inequality across lives and cohorts, such as educational systems, working conditions, income inequality, health care, and the generosity of the welfare state.

APPENDIX

TABLE A1: HIERARCHICAL LINEAR MODELS FOR CHRONIC CONDITIONS

	Model 1 Number of Chronic Conditions		Model 2 High Blood Pressure		Model 3 Diabetes	
Intercept	0.27*	(0.12)	0.18*	(0.07)	0.026	(0.05)
Age (minimum-centered)	0.0076	(0.01)	0.014*	(0.01)	-0.0010	(0.00)
Age (minimum-centered) squared	0.0015**	(0.00)	0.000055	(0.00)	0.00061**	(0.00)
US (ref. SE)	0.36**	(0.13)	0.19*	(0.08)	0.087	(0.05)
US x Age	0.048***	(0.01)	0.014*	(0.01)	0.012*	(0.01)
US x Age squared	-0.00097	(0.00)	-0.00046	(0.00)	-0.00044	(0.00)
Education (ref. Lower)						
Intermediate	0.14	(0.14)	0.069	(0.09)	0.038	(0.06)
Higher	0.0064	(0.15)	-0.0044	(0.09)	-0.011	(0.06)
Age x Education						
Age x Intermediate	-0.010	(0.01)	-0.0018	(0.01)	0.00024	(0.01)
Age x Higher	-0.022	(0.01)	-0.013	(0.01)	-0.0035	(0.01)
Cohort	0.014	(0.02)	-0.0078	(0.01)	0.0093	(0.01)
Age x Cohort	-0.0018	(0.00)	0.00033	(0.00)	-0.00098	(0.00)
Cohort x Education						
Cohort x Intermediate	-0.017	(0.02)	-0.011	(0.01)	-0.00023	(0.01)
Cohort x Higher	-0.0033	(0.02)	0.0033	(0.01)	-0.0012	(0.01)
Age x Cohort x Education						
Age x Cohort x Intermediate	0.00057	(0.00)	0.00021	(0.00)	-0.00039	(0.00)
Age x Cohort x Higher	0.0012	(0.00)	0.00034	(0.00)	0.00024	(0.00)
US x Education						
US x Intermediate	-0.30*	(0.15)	-0.15	(0.10)	-0.085	(0.07)
US x Higher	-0.23	(0.16)	-0.13	(0.10)	-0.037	(0.07)
US x Education x Age						
US x Intermediate x Age	0.0036	(0.01)	0.00068	(0.01)	0.0011	(0.01)
US x Higher x Age	-0.00080	(0.01)	0.0094	(0.01)	-0.0030	(0.01)
US x Cohort	-0.048*	(0.02)	-0.010	(0.01)	-0.016	(0.01)
US x Age x Cohort	0.0015	(0.00)	0.00040	(0.00)	0.00089	(0.00)
US x Education x Cohort						
US x Intermediate x Cohort	0.027	(0.02)	0.015	(0.01)	0.0019	(0.01)
US x Higher x Cohort	0.0098	(0.02)	-0.00055	(0.01)	-0.00017	(0.01)
US x Education x Cohort x Age						
US x Intermediate x Cohort x Age	-0.00041	(0.00)	-0.000069	(0.00)	0.00019	(0.00)
US x Higher x Cohort x Age	-0.000093	(0.00)	-0.00016	(0.00)	0.00014	(0.00)
Controls						
Male (ref. Female)	-0.23*	(0.12)	-0.15*	(0.08)	-0.014	(0.05)
Male x Age	0.019	(0.01)	0.0087	(0.01)	0.0013	(0.00)
Male x Cohort	0.026	(0.01)	0.026**	(0.01)	-0.00016	(0.01)
Male x Age x Cohort	-0.0013	(0.00)	-0.0015*	(0.00)	0.00036	(0.00)
Male x US	0.20	(0.13)	0.16	(0.08)	0.022	(0.06)
Male x Age x US	-0.0100	(0.01)	-0.0017	(0.01)	0.0027	(0.00)
Male x Cohort x US	-0.037*	(0.02)	-0.028**	(0.01)	-0.0021	(0.01)
Male x Age x Cohort x US	0.0016	(0.00)	0.00097	(0.00)	-0.00049	(0.00)
Died (ref. Alive)	0.50**	(0.18)	0.19	(0.10)	0.17*	(0.08)
Died x US	0.25	(0.19)	-0.040	(0.11)	0.046	(0.08)
Dropout (ref. Non-dropout)	-0.011	(0.04)	-0.015	(0.03)	-0.017	(0.02)
Dropout x US	0.048	(0.05)	0.026	(0.03)	0.025	(0.02)
Variance components						
Residual (Level 1)	0.074***		0.028***		0.0148***	
Intercept	1.035***		0.428***		0.191***	
Age	0.005***		0.002***		0.001***	
Covariance of intercept and age	-0.046***		-0.019***		-0.009***	
N (individuals)	9,384		9,385		9,385	
N (observations)	38,612		38,620		38,620	

Note: HRS, release 2014; SHARE, release 2015. Standard errors in parentheses; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

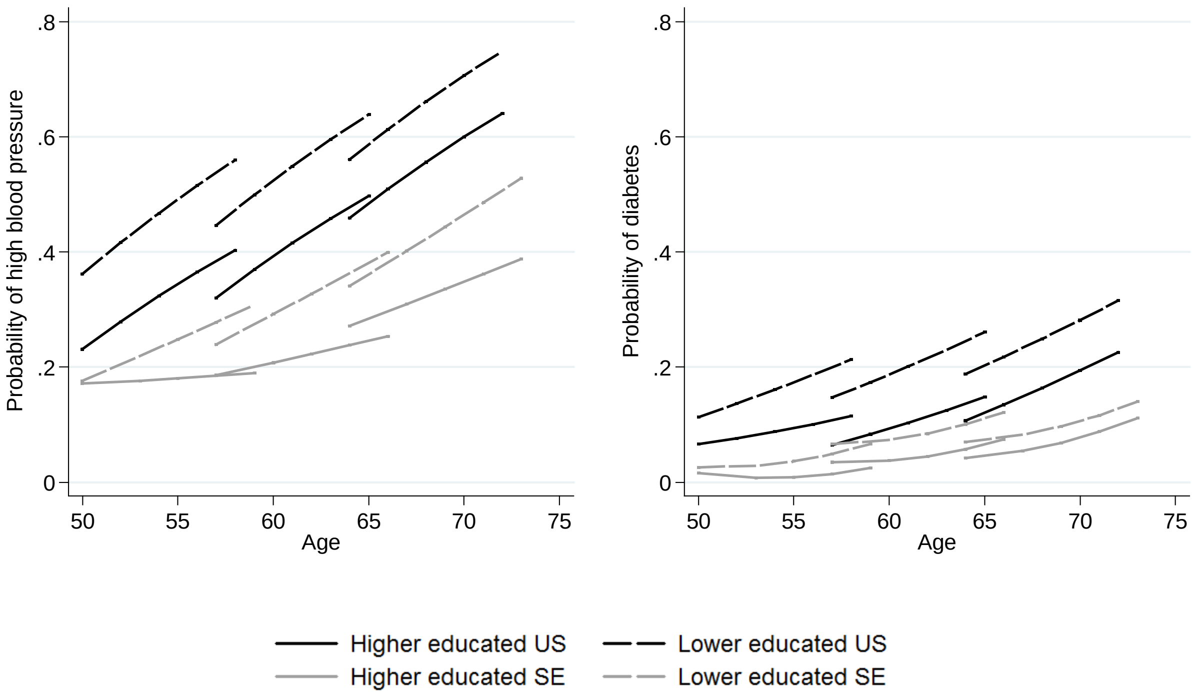

FIGURE A1: PREDICTED AGING VECTORS FOR THE PROBABILITY OF HIGH BLOOD PRESSURE AND DIABETES BY EDUCATION AND COUNTRY

Note: HRS, release 2014; SHARE, release 2015; predictions are based on the estimates from Models 2 and 3, Table A1.

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Chapter IV

Education and Health Across Lives and Cohorts: A Study of Cumulative (Dis)advantage in Germany[5]

Abstract

Research from the United States has supported two hypotheses about health inequality. First, educational gaps in health widen with age – the cumulative (dis)advantage hypothesis. Second, this relationship has intensified across cohorts – the rising importance hypothesis. We estimate hierarchical linear models using 23 waves of panel data (SOEP, 1992–2014) to test both hypotheses in the German context, which contrasts sharply with the U.S. in the structural forces shaping health inequality. We considered individual and contextual influences on the association between education and health, and we assessed gender differences in health trajectories over the life course (ages 23 to 84) and across cohorts (born between 1930 and 1969). The results showed no support for either hypothesis among women, as educational gaps in self-rated health remained stable with age and did not change across cohorts. Among men, both hypotheses were supported, as educational gaps in self-rated health widened with age, and increasingly so in newer cohorts.

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Introduction

Education is one of the most important predictors of health and mortality (Kitagawa and Hauser 1973). Beneficial effects of higher education and adverse effects of lower education on health are transmitted via health-related resources such as work environments, economic means, social support, and health behaviors, as well as the abilities to self-regulate and to cope with stressors (Ross and Mirowsky 2003). Over the past decades, the relationship between education and health has been intensely studied and found to be pronounced in all advanced societies (Mackenbach 2012).

This picture becomes less clear, however, when viewed from a life course perspective. Initial studies of age effects on educational health differences yielded contradictory findings of divergence, persistence, or even convergence over the life course (Ross and Wu 1996; House et al. 1994; Clark and Maddox 1992). This puzzle was later resolved by studies that situated educational health gradients within their socio-historical context. These studies have shown that seemingly persistent or convergent trajectories emerged as artifacts from analyses that ignored cohort patterns and their interactions with age and education (Lynch 2003). By considering cohort effects, recent investigations have produced consistent results: Educational gaps in health increase over the life course, supporting the cumulative (dis)advantage hypothesis, which predicts initial health-related advantages and disadvantages to accumulate with age (Willson et al. 2007). Moreover, this divergence was found to intensify across cohorts, a result that has been termed "rising importance of education for health" (Goesling 2007; Mirowsky and Ross 2008).

A general conclusion from this line of research is that educational differences in health trajectories are shaped by the social conditions surrounding different cohorts. Yet, the importance of context is still not widely recognized in the literature. The prime interest remains in processes of individual aging rather than the social context in which these processes unfold (Hayward and Sheehan 2016; Herd 2016).

The neglect of context is particularly reflected in the near absence of cross-national research on educational differences in health over the life course. Pertinent studies are almost exclusively based on U.S. data. Because of this focus, variation in national context has not been considered either theoretically or empirically. This is an important omission, given that the inclusion of other country contexts offers novel insight into key factors such as the role of educational systems in the creation of health inequality and the role of social policy in targeting this inequality.

In view of that, we designed the present study to contribute to the literature in two main ways. First, we addressed individual and contextual influences on the association between education and health, viewing it (a) from a life course perspective considering individual age-related change, (b) from a cohort perspective considering socio-historical change, and (c) through a gendered lens considering how structural forces may differentially shape men's and women's health across their life courses.

Second, we conducted the first study of the cumulative (dis)advantage and the rising importance hypotheses in the German context. Health inequality in Germany is shaped by opposing social forces: On the one hand, Germany's educational system inhibits social mobility and strongly determines socio-economic positions in later life (Allmendinger 1989). This setting appears to be conducive to the accumulation of initial advantages and disadvantages. On the other hand, the German welfare state is designed to alleviate the resulting inequalities, comprising various measures that might inhibit divergence in educational health trajectories. In light of these contrasts, Germany represents an interesting setting to shed new light on both hypotheses.

In our data from the German Socio-economic Panel Study (SOEP), information about self-rated health has been collected annually between 1992 and 2014, allowing us to trace individual health trajectories over more than twenty panel waves. This observation window is of unprecedented range, yielding large overlaps between age and cohort that are ideally suited to disentangle their effects.

The Cumulative (Dis)advantage Hypothesis

According to the cumulative (dis)advantage perspective, initial advantages or disadvantages associated with structural positions accumulate over time. Advantages and disadvantages are usually defined in terms of access to resources and exposure to risks (Dannefer 1987, 2003; DiPrete and Eirich 2006; Ferraro and Shippee 2009; Ferraro et al. 2009; Merton 1967; O'Rand 1996). The concept of cumulative (dis)advantage has informed various analyses of changing inequality. An assumption that underlies these analyses is that by the mechanisms of accumulation and path-dependency inequality increases within a cohort that is followed over time (Dannefer 1987, 2003).

Life-course research on education and health is rooted in this tradition. Education stratifies a wide range of health-related resources and risks, as it reproduces and magnifies early advantages and disadvantages related to social background and strongly determines income, occupational status, and wealth over the adult life course (Kerckhoff 1995). Depending on their social background, children grow up in stable or unstable families, attend better or worse schools, and reach higher or lower occupational positions. These, in turn, protect them from or expose them to unfavorable working conditions and the "allostatic load" of stress associated with economic hardship (McEwen 1998). Moreover, education, or the lack thereof, promotes or impedes the acquisition of resources such as learned effectiveness and sense of personal control, each of which contributes to healthy life styles (Mirowsky and Ross 2003).

The health consequences of educational differences in resources and risks surface as people age. In young adulthood, higher and lower educated people are generally healthy, and disparities in health-relevant factors such as physical activity have not yet taken their toll (House et al. 1990, Ross and Wu 1996). With age, differences in these factors increasingly translate into educational disparities in health. Differences in physical activity, for example, gradually translate into differences in health measures such as overweight, joint problems, and number of chronic conditions (Ross and Wu 1996). This applies similarly to various health-related factors. On average, the lower educated have less access to resources such as economic means, favorable working environments, social support, and personal sense of mastery. As a result, the lower educated are not only more exposed to health risks but also more vulnerable to the adverse consequences of these risks. The higher educated, in contrast, are not only less exposed to health risks but also in a better position to compensate for their adverse effects on health. Life-course studies of health inequality have argued that these differences translate into an intra-cohort increase in the health gaps between lower and higher educated people across the major life stages (Ross and Wu 1996; Mirowsky and Ross 2008; Lynch 2003; Willson et al. 2007).

In previous studies on health inequality, a widening gap between health trajectories with age is commonly interpreted as evidence for the cumulative (dis)advantage hypothesis (Herd 2006; Kim 2008; Kim and Durden 2008; Lynch 2003; Mirowsky and Ross 2008; Ross and Wu 1996; Willson et al. 2007). In keeping with this literature, the current study also examines the cumulative (dis)advantage hypothesis on the basis of aggregate-level health trajectories. It is important to note, however, that an aggregate-level pattern of widening health gaps between educational groups does not necessarily emerge from processes of accumulation at the individual level (Dupre 2007). Conversely, an absence of this pattern does not necessarily indicate the absence of such processes at the individual level. In light of these complications, caution is warranted about conclusions regarding the mechanisms underlying aggregate-level health trajectories (Allison et al. 1982; Bask and Bask 2015).

Previous Evidence

Pioneering research on educational inequality in health trajectories produced mixed findings. Some studies were consistent with the cumulative (dis)advantage hypothesis, reporting the expected age-related increase in health differences between educational groups (e.g., Ross and Wu 1996). Others found that educational health gaps remained stable or even narrowed with age (e.g., Clark and Maddox 1992; Herd 2006; House et al. 1994). These contradictory findings fueled an intense debate. An important conclusion to emerge from this debate was that cross-sectional or short-term longitudinal data are ill-suited to examine health trajectories of educational groups. Only longitudinal data allow the analysts to account for two potential sources of bias, selection effects and cohort effects (Beckett 2000; Noymer 2001; Lynch 2003).

Two types of *selection effects* – attrition due to health problems and premature mortality – may compress the estimated health differences between educational groups (Noymer 2001). Whereas higher rates of attrition among the lower educated constitute a bias in the data, higher rates of mortality among the lower educated have been reconsidered as a substantive outcome of a process of cumulative (dis)advantage. Given that death in older age typically ends a trajectory of steep physical health decline (Hayward and Sheehan 2016), educational differences in mortality constitute a part of the phenomenon under study (Lynch 2003; Willson et al. 2007; Dupre 2007; Ferraro et al. 2009; Rohwer 2016). This means that divergence in educational health differences might be compressed or even replaced by convergence although this aggregate-level pattern may still result from individual-level processes of accumulating (dis)advantages.

A second potential source of bias are *cohort effects*. Studies that ignore cohort effects implicitly assume that health trajectories remain unchanged across cohorts. This assumption appears unwarranted, given that health-relevant conditions surrounding individuals from different birth cohorts have changed considerably. In fact, Lynch (2003) has demonstrated that the results on the cumulative (dis)advantage hypothesis will be biased, if the distribution of health-related advantages and disadvantages between educational groups has changed across cohorts. If divergence intensifies across cohorts, for example, cross-sectional designs will produce the opposite result, indicating convergence with age. In the U.S., several studies have addressed this problem, using panel data to disentangle age and cohort patterns in the relationship between education and health. These studies consistently found that health gaps between educational groups widened with age (Lynch 2003; Willson et al. 2007; Mirowsky and Ross 2008; Kim 2008; Kim and Durden 2007).

Gender differences

Recent research from the U.S. has argued that the intersection between gender and social stratification creates different contexts for men's and women's health trajectories. Because gendered norms and practices are socially stratified, higher or lower education may differentially structure health-related resources over the life course (Pudrovska 2014). According to the "reinforcement of advantage"[6] hypothesis, men translate education more effectively into economic advantage and disadvantages, along with their beneficial or adverse

[6] This hypothesis is also known as "resource multiplication" hypothesis (Ross and Mirowsky 2006).

effects on health (Ross and Mirowsky 2006; 2010). Consequently, educational gaps in health are expected to grow faster among men.

A competing perspective posits that educational health gaps accumulate more rapidly among women. According to the “resource substitution” hypothesis, education may improve women’s health more than men’s health because women can draw on fewer alternative socioeconomic resources (Ross and Mirowsky 2010). An additional argument highlights differential socialization. In their roles as future mothers, women are socialized to be more attentive to health matters (Reczek and Umberson 2012). In this process, education determines their capacity to understand health-relevant information, implement it into daily life, and thus, maintain good health (Pudrovska 2014).

Empirical evidence from the U.S. has supported the latter perspective, indicating a stronger increase in educational differences among women in physical impairment (Ross and Mirowsky 2010) and mortality (Pudrovska 2014). Moreover, educational gaps in self-rated health have been found to widen more rapidly among women over the past decades (Liu and Hummer 2008).

The Rising Importance Hypothesis

Demographic research has shown that educational disparities in health and mortality increase over time (Lauderale 2001; Elo and Preston 1996). These results reverberated through the U.S. literature in medical sociology, leading to the formulation of the “rising importance” hypothesis. This hypothesis states that that the rate at which health trajectories diverge across educational groups has increased in newer cohorts (Mirowsky and Ross 2008).

The rising importance hypothesis is based on two arguments. Each of these arguments highlights changes that are specific to the U.S. context. The first focuses on change in the distribution of health-related resources, such as material means and health behaviors. In the U.S., the relationship between education and income has intensified (Hout 2012). In the absence of welfare state intervention, quality of living, exposure to stressors, and access to health care are highly dependent on financial means (Lynch 2006). Through this pathway, growing educational differences in income may have increased health gaps in more recent cohorts (Goesling 2007).

The relationship between education and health-related behaviors has also intensified. Following the epidemiologic transition from infectious to chronic diseases from the 1960s onward, the stock of information about health and preventive behaviors has expanded greatly. Higher educated individuals in the U.S. have not only disproportionally improved their health behaviors by optimizing their diet, exercising more, and smoking less, but also taken more advantage of new health services and medical technology (Harper and Lynch 2007; Lleras-Muney and Lichtenberg 2002).

The second argument emphasizes compositional change and selection. With educational expansion and upward social mobility, the group of lower educated individuals is shrinking. As a result, lower educational groups might represent an increasingly negative selection of individuals on characteristics such as early health condition, cognitive ability, and sense of control (Haas 2006).

U.S. studies have supported the rising importance hypothesis (Lynch 2003; Mirowsky and Ross 2008). Furthermore, the data were consistent with the main explanations that have been proposed for this trend, suggesting that widening health gaps emerge from distributional change in health-related resources (Lynch 2006) as well as compositional change of educational groups (Goesling 2007).

The German Context

Knowledge about how educational differences in health trajectories change with age and across cohorts remains almost exclusively limited to the U.S. context. From a cross-national perspective, it is important to consider whether the social forces that have shaped health trajectories within the U.S. context apply to a lesser, similar, or greater extent in other countries. For the German context[7] of the present investigation, extant research suggests marked differences compared with the U.S. In Table 1, we summarize these differences. Our comparison considers all key arguments on which the hypotheses of cumulative (dis)advantage and rising importance are based. As shown in the table, some of these arguments fit more closely with the German context (DE > US), whereas others fit more closely with the U.S. context (DE < US).

– Table 1 –

Cumulative (dis)advantage, education and health in Germany

The educational system strongly connects social origin to social destination both in the U.S. and in Germany, but the role of education as a "sorting machine" is particularly salient in the German context. Germany is a textbook example for a selective and rigid school system, which translates educational degrees into occupational positions. These conditions favor the reproduction of initial advantages and disadvantages related to social origin, and stratify economic outcomes over the life course along educational lines (Allmendinger 1989).

These properties are mainly attributed to early educational tracking and the strong vocational orientation of education. Based on their performance in the 4th grade, children are

[7] All considerations refer to the West German context.

tracked into three hierarchically structured educational pathways: lower secondary (Hauptschule), intermediate secondary (Realschule), and higher secondary (Gymnasium). Because performance at this young age highly depends on learning environments in families, early tracking strongly reproduces initial advantages and disadvantages of family background and exacerbates initial differences in cognitive ability, self-regulation, and economic means, suggesting pronounced accumulation of health-relevant resources in early life.

These early disparities are intensified by the vocational orientation of the German educational system and its close connection to the labor market (Shavit and Müller 1998). In contrast to the U.S. where employers focus more on performance on the job (Daly 2000), vocational qualifications are crucial for attaining occupational positions in Germany (DiPrete et al. forthcoming; Müller et al. 1998). Moreover, occupational mobility over the life course is exceptionally low in Germany. Throughout their working lives, individuals remain exposed to favorable or unfavorable working conditions associated with higher or lower occupational positions (Mayer et al. 2009).

Compared with the U.S., these characteristics of the German educational and occupational systems create an even more fertile breeding ground for the accumulation of initial advantages and disadvantages in health-related resources. The reverse picture, however, emerges for the remaining arguments behind the cumulative advantage hypothesis. These arguments pertain to the steady increase of educational disparities in health-related resources over the life course. All of these arguments fit more closely with the U.S. context. Regarding labor market factors, U.S. studies have highlighted material means as a driving force of increasing health inequality over the life course (Lynch 2006). Less attention has been devoted to the fact that the link between material means and health is tightened by institutional characteristics that are specific to this context. In the U.S., the welfare state provides only basic social protection (Social Security Program) and offers access to health care (Medicare) only after the age of 65. Given the low levels of social protection against risks across major stages of the adult life course, level of living, access to health care, and the degree of stress associated with negative life events strongly depends on individuals' material means. Moreover, the distribution of these resources is highly unequal, rendering those who are most susceptible to adverse events unable to respond.

In Germany, income inequality between educational groups is considerably smaller (Freeman 1994), and income is less strongly linked to health (Klein and Unger 2001). The German welfare state ensures a comparatively high standard of living regardless of economic means. Furthermore, employment protection is strong, payments in case of unemployment, long-term sickness or disability are generous (DiPrete 2002), health insurance is mandatory, and access to health care is universal.

Finally, educational gaps in health behaviors and related competencies are also more pronounced in the U.S. than in Germany. For the U.S., Mirowsky and Ross (2007) have shown that educational differences in sense of personal control increase markedly with age. A replication of this analysis with data from West Germany found no such effect (Specht et al. 2013). Related to that, highly educated individuals in the U.S. lead much healthier lifestyles than their lower educated counterparts. These differences in smoking, physical activity, and preventive health care are smaller in Germany (Cockerham et al. 1986; Pampel et al. 2015).

Consideration of these factors suggests that the life course pattern implied by the cumulative (dis)advantage hypothesis – a steady increase of educational health disparities – may apply less to the German context. Unlike in the U.S. where policy measures aimed at reducing health disparities are implemented only in older age, the German welfare state targets health inequality throughout adulthood.

Empirical evidence from Germany seemingly supports this view. No divergence was found in health trajectories between educational groups (Schöllgen et al. 2010; Knesebeck 2005). These results, however, are based on cross-sectional data. As noted, if health gaps increase with age – a pattern implied by the cumulative (dis)advantage hypothesis – and if this divergence intensifies across cohorts – a pattern implied by the rising importance hypothesis – these processes may offset each other in an estimation that does not separate age and cohort effects. Consequently, it remains unclear whether findings of continuous or even converging educational health gaps result from the generosity of the German welfare state of from the use of inadequate empirical designs.

Rising importance of education for health in Germany

U.S.-based formulations of the rising importance hypothesis emphasize two factors: (1) increasing inequality in the distribution and use of health-related resources, and (2) compositional change of educational groups. As shown in Table 1, the first factor fits more closely with the U.S. context, whereas the second factor fits more closely with the German context.

Looking at change in the distribution and use of health-related resources, the U.S. have witnessed a steep rise of inequality in economic returns to education. In Germany, this trend was less pronounced, albeit still present. Compared to people born before and during the war, post-war and baby boom cohorts have experienced declining returns to education in terms of income and job security (Bookmann and Steiner 2006). These changes were most pronounced among the lower educated, whereas the higher educated maintained comparatively high and stable educational returns. Unlike in the U.S., however, these changes in the distribution of economic resources have not been accompanied by growing educational disparities in health-related behaviors (Pampel et al. 2015). Educational differences in smoking, drinking, physical exercise, and obesity have remained stable. A slight increase of educational differences in these behaviors was found only in the most recent cohorts (Kroll 2010).

The second factor motivating the rising importance hypothesis – compositional change of educational groups – fits more closely with the German context. Unlike in the U.S., where size and composition of higher as well as lower educational groups have changed considerably across cohorts, this trend was largely one-sided in Germany. Higher education expanded only modestly, and mainly among post-war cohorts. After this initial increase, the share of tertiary degrees has settled down at approximately 20 percent (Solga 2002) – compared to about 40 percent in the U.S. (Goldin and Katz 2009). In contrast, the group of lower educated individuals (i.e., up to lower secondary degrees with vocational training) shrank dramatically from over 70 percent in pre-war cohorts to about 20 percent among those born in the 1970s (Solga 2002). This development is commonly attributed to the expanding service sector and "skill-biased technological change" (Autor et al. 1998). Jobs increasingly require higher levels of cognitive ability and knowledge. Since the 1980s, intermediate and, increasingly, higher secondary degrees became a requirement for accessing most vocational tracks in Germany (Klein 2011). The group of those who fail to attain these degrees is increasingly composed of the most disadvantaged people in terms of family background, cognitive skills, and other health-relevant resources. The group of higher educated, in contrast, has changed little in these respects (Jürges et al. 2011).

These considerations suggest that although the basic expectation of "rising importance" applies in both societies, the social forces driving this change are different. In the U.S., the rising importance of education for health has been primarily attributed to increasing advantages among the highly educated, such as growing economic returns and disproportionate improvements in health behaviors. Slower health declines in this group can be expected to drive the process of rising importance. In Germany, cross-cohort trends suggest the reverse pattern: Whereas the higher educated have not changed much in their educational returns, health behaviors, and compositional characteristics, the lower educated have experienced declines in returns to education and become more negatively selected on health-relevant characteristics. The rising importance of education for health should therefore result from steeper health declines among the lower educated, rather than flatter health declines among the higher educated.

Gender differences in the German context

In U.S. studies, educational health gaps were found to grow faster among women (Pudrovska 2014; Ross and Mirowsky 2010). In the German context, consideration of such differences is particularly important, as the structure of the life course is strongly gendered. Compared with the U.S., Germany offers two contrasts. First, the “resource substitution” hypothesis – which has been supported in the U.S. – is less applicable to the life courses of German women. Hypergamy has long been the norm, weakening the link between women’s level of education and their social position. Moreover, after motherhood, most women either left the labor force for good or returned only on a part-time basis (Blossfeld 2009). Both of these characteristics constitute pathways through which German women were able to compensate for a lack of education.

Second, the “reinforcement of advantage” hypothesis – which has not been supported in the U.S. – fits closely with the life courses of German men. This applies especially to two critical links between education and health, labor-market outcomes and health behaviors (Boockmann and Steiner 2006). The German welfare state has long been organized around a male-breadwinner model that encourages gender specialization by combining tax incentives with low coverage of public childcare (DiPrete 2002). As a result, the labor market factors highlighted by the cumulative (dis)advantage hypothesis apply more strongly to men's than to women's life courses in Germany. The same is true for risky health behaviors. In this domain, educational differences are much larger among men. In smoking prevalence, the gap amounts to twenty-six percentage points among men (30% of high educated and 56% of low educated Germans smoke), compared to only eight percentage points among women (20% versus 28%) (Pampel 2010).

Data and Method

Sample

Our analysis is based on data from the German Socio-Economic Panel Study (SOEP), a large-scale, representative household and individual study (Wagner et al. 2007). In 1984, the SOEP started in West Germany with a sample population of approximately 12,000 individuals living in 6,000 households. Since 1992, the SOEP collects data about self-rated health at each annual wave.[8] Our analysis draws on these data from an observation period between 1992 and 2014, yielding up to 23 measurements of self-rated health per individual.

In 1992, the anchor year of our study, the sample comprised 13,397 individuals. From this sample, we excluded immigrants and persons from the Former GDR, limiting the study population to West Germans. These sample restrictions ensured that individuals shared a common context with regard to educational degrees, returns to those degrees, and life conditions associated with cohort membership. We further constrained the sample to persons born between 1930 and 1968. Most men born before 1930 were enlisted to fight in the war and

[8] The only exception is the 1993 wave.

might constitute a particularly selective group of survivors. The upper bound of 1968 marked the end of the baby boom cohorts. After all restrictions, our analytic sample consisted of 4,629 individuals aged 24 to 62 in the anchor year of 1992, comprising 68,402 person-years across the observation period until 2014.

The SOEP data combine a large range of cohorts with an extensive window of observation. A major benefit of these data is that they allow for two types of analyses: First, a model in which linear change across cohorts is captured by interactions with age and education. This is a common approach in analyses of cumulative (dis)advantage (Willson et al. 2007). Second, models in which educational health trajectories are analyzed for different groups of cohorts, which are separated on theoretical grounds.

Given the large age overlaps between cohorts in our sample, our data yield a nuanced picture of cohort effects, allowing for linear and non-linear change. For the non-linear cohort analysis, we assigned respondents to three groups: (1) pre-war and war cohorts born between 1930 and 1945, (2) post-war cohorts born between 1946 and 1956, and (3) baby boom cohorts born between 1957 and 1968. These groups are not equal in span, but theoretically meaningful in the sense that their life courses were shaped by similar socio-historical conditions.

Measure of health

Self-rated health (SRH), is widely regarded as a valid measure of health. It is highly correlated with morbidity and functional limitations and constitutes a potent predictor of mortality (Idler and Benyamini 1997). In the SOEP, data about SRH are based on the annual survey question "How would you describe your current health?" Respondents answer on a scale from 1 (very good) to 5 (bad). We reverse-coded this variable so that lower values indicated worse health.

To examine the robustness of our findings on SRH, we performed additional analysis using the Physical Component Scale (PCS). We only use this measure for robustness checks, because it has was first collected in 2002. PCS is a standard indicator of physical health in the general population. In a wide range of cross-sectional, longitudinal and internationally comparative studies, the PCS has been shown to detect hypothesized differences in nearly all tests based on physical criteria (Burdine et al. 2000; Gandek 1998). A key benefit of the PCS – in particular compared with the measure of SRH – is its high sensitivity to change in physical health both at younger ages and especially in later life (Ware et al. 1994). Unlike SRH, the PCS captures general health assessments as well as more specific physical health conditions. The calculation of the PCS is based on a multi-item scale that evaluates four physical health concepts: 1) limitations in physical activities because of health problems; 2) limitations in usual role activities because of physical health problems; 3) bodily pain; 4) general health perceptions (Ware and Sherbourne 1992). In the SOEP data, the PCS score was calculated by the SOEP group (Nübling et al. 2007) on the basis of the SF-12v2 questionnaire (Fleishman et al. 2010). This information was collected biannually since the year 2002.[9] The analyses based on this additional health measure led to the same substantive conclusions and the results are available upon request.

Estimating the measures of SRH coupled with robustness checks using PCS, we were able to tie our analyses closely to previous U.S. studies predicting change in SRH (e.g., Willson et al. 2007; Mirowsky and Ross 2008) as well as two German studies that relied on both measures (Schöllgen et al. 2010, Schmidt et al. 2012).

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[9] Because the order, formulation, and layout of the questions deviated to some extant from the initial SF-12v2 questionnaire, the SOEP group used its own computation algorithm which essentially replicated the standard procedure (Fleishman et al. 2010). The reference year of the PCS scale is 2004. In this year, the PCS was calculated with a mean of 50 and a standard deviation of 10 (Nübling et al. 2007).

Measures of cohort and age

For the linear cohort model, we centered birth year at the mean age of entry, equaling zero for those who were initially observed at the age of 41 in the year 1992 (i.e., born in 1951). Higher values of this cohort variable denote older cohorts. *Age* was measured in years, ranging from 24 to 83. For the analysis of the linear cohort model, we centered the age variable at the grand median of 49 years. In the non-linear cohort model, age ranged from 47 to 83 in the pre-war and war cohort, from 36 to 67 in the post-war cohort, and from 24 to 56 in the baby boom cohort. For this model, we centered age at the minimum of each cohort. Similar to comparable U.S. studies (Willson et al. 2007; Lynch 2003), a linear function provided the best representation of age effects on health in all models. Table 2 presents descriptive statistics for the total sample and separately by the three cohort groups.

TABLE 2. DESCRIPTIVE STATISTICS: TOTAL SAMPLE AND SEPARATELY BY COHORTS

	Total				Pre-war and war cohorts 1930-45				Post war cohorts 1946-56				Baby boom cohorts 1957-68			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Self-rated health[a]	3.28	0.92	1	5	2.98	0.91	1	5	3.24	0.90	1	5	3.56	0.85	1	5
Age	49.5	12.7	24	83	62.8	7.34	47	83	49.6	6.96	36	67	38.0	7.05	24	56
Median-centered	0.46	12.7	-25	34												
Minimum-centered					15.8	7.34	0	36	13.6	6.96	0	31	14.0	7.05	0	32
Cohort																
Year of birth	1951	11.2	1930	1968	1938	4.3	1930	1945	1951	3.2	1946	1956	1963	3.4	1957	1968
Age in 1992	41	11.2	24	62												
Mean-centered	0	11.2	-17	21												
Education[b]																
Lower	0.52		0	1	0.67		0	1	0.53		0	1	0.38		0	1
Intermediate	0.33		0	1	0.22		0	1	0.30		0	1	0.43		0	1
Higher	0.16		0	1	0.11		0	1	0.17		0	1	0.19		0	1
Male	0.49		0	1	0.49		0	1	0.49		0	1	0.50		0	1
Dropout																
Died	0.09		0	1	0.21		0	1	0.06		0	1	0.02		0	1
Left panel	0.59		0	1	0.55		0	1	0.59		0	1	0.62		0	1
Obs. per individual	14.8	7.26	1	22	14.7	7.35	1	22	14.9	7.23	1	22	148	7.20	1	22
N (observations)	68,402				22,715				18,897				26,790			
N (individuals)	4,629				1,550				1,266				1,813			

SOEP, release 2014. [a] 5-point scale, reverse coded (1 = bad, 5 = very good). [b]Lower = CASMIN 1a-c (up to lower secondary vocational degree); intermediate = CASMIN 2a-c (up to higher secondary plus vocational training); higher = CASMIN 3a-b (lower and higher tertiary).

Measures of education

In U.S. studies of health inequality, education is commonly measured in years of schooling. In the present study, we instead used indicator variables for educational degrees. There are two reasons for this. First, a growing body of evidence suggests that the relationship between education and health is non-linear, given that incremental increases in years of education do not translate into similar benefits for health (Zajacova et al. 2012). Second, in the German context, meaningful differences are better captured by educational degrees than by years of education. Due to educational tracking of students into three separate school forms, individuals who attended different tracks (but for the same number of years) differ substantially in health-relevant characteristics such as family resources and cognitive ability. Moreover, as explained above, institutional characteristics such as entry requirements in the labor market render educational degrees and especially vocational qualifications more important than years of schooling for economic outcomes in adult life (Bookman and Steiner 2006).

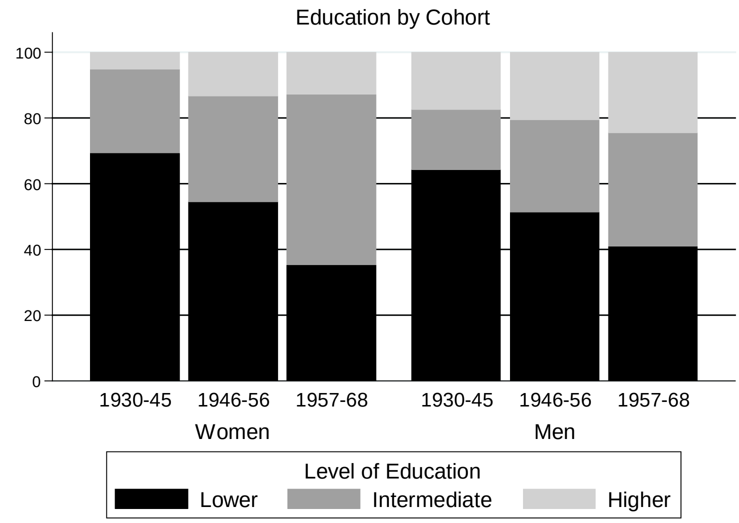

FIGURE 1: DISTRIBUTION OF EDUCATIONAL LEVELS BY COHORT

SOEP, release 2014. *N* = 4,629. Lower education = up to lower secondary vocational degree (CASMIN 1a-c). Intermediate education = up to higher secondary degree plus vocational training (CASMIN 2a-c). Higher education = lower and higher tertiary degree (CASMIN 3a-b).

We measured educational degrees by the CASMIN classification (Brauns et al. 2003). This variable indicates the *highest* educational degree reported by respondents within the observation period. Figure 1 shows the distribution of educational degrees in the three cohort groups separately by gender. We grouped the CASMIN categories as follows: the bottom category comprised individuals holding lower secondary degrees with completed vocational qualification or less (CASMIN 1a–1c); intermediate education ranged from intermediate secondary degrees to higher secondary degrees with vocational qualification (CASMIN 2a–2c); the top category included respondents holding tertiary degrees (CASMIN 3a–3b). As described above, educational expansion in post-war Germany involved a shift primarily from lower to intermediate levels of education, whereas the proportion of higher educated individuals changed less. These trends are clearly recognizable in Figure 1.

Controls for period effects

To test the hypotheses of cumulative (dis)advantage and rising importance, our analysis focused on educational differences in the effects of age and cohort. The *age effect* indicates health declines within individuals, as they grow older. The *cohort effect* captures health differences between individuals, arising from their "unique location in the stream of history" (Ryder 1965, p. 844), which exposes people of similar age to the same socio-historical conditions. To estimate both effects from longitudinal data, it is important to control for a third source of temporal variation in health: *Period effects* are social changes that occur across the observation window and simultaneously affect the health of all individuals, irrespective of their age.

There is no technical solution to control for period in a model that includes age and cohort, because the three terms are exactly mathematically dependent (Period = Cohort + Age). One solution to this identification problem is to exclude period from the model, assuming that these effects are zero. Previous research on cumulative (dis)advantage and rising importance is implicitly based on this assumption, given that period effects have not been considered either theoretically or empirically. Although these studies did not discuss the validity of this assumption, it may still be justified, as analyses were mostly based on relatively short observation periods. In the present study, we draw on a much longer observation window. Although this yields major benefits for disentangling age and cohort effects, the assumption of no period effects is less likely to hold (Yang and Land 2013).

To account for this potential source of bias in the estimation of age and cohort effects, we adopted a factor characteristic approach (O'Brien 2015) that represents period effects by measures of health-relevant changes across the observation window. This approach circumvents the identification problem by associating period with its substantive characteristics that may affect health across all ages (Winship and Harding 2008). Similar to constrain-based solutions to the identification problem (Mason et al. 1973; Yang and Lang 2013), the validity of this approach must be justified on theoretical grounds: Period effects are controlled only to the extent that the factor characteristic variables capture all relevant changes across the observation window that have affected health independently of age.

To motivate our selection of factor characteristics, we considered three possible sources of such changes. First, economic shifts are known to affect health across various age groups. This applies especially to economic downturns, which not only cause stress due to job loss but also entail spillover effects on the inactive population, for example through worsening of living conditions (Stuckler et al. 2009). We measured economic shifts by (a) the unemployment rate and (b) year-to-year change in GDP for every year between 1992 and 2013. These characteristics were only slightly correlated throughout our observation window (r = 0.09). Although GDP has frequently been used in comparative research on health inequality, research has shown that unemployment captures health-relevant effects most directly (Tapia-Granados 2005).

Second, policy interventions may cause improvements or declines in population health. An obvious candidate in this regard is the reduction of emissions that has improved the quality of air to the benefit of everybody. Progress on this front, however, mainly occurred before the 1990s and thus, outside our observation window (Umweltbundesamt 2015). A policy shift within this window was the smoking ban introduced in 2007. The benefits of this intervention, however, mainly concerned younger people, who were less likely to take up or continue smoking and were less exposed to passive smoking in bars and discotheques (Lampert et al. 2013). Given this strong age dependence, the consequences of the smoking can be considered cohort effects rather than period effects. On these theoretical grounds, we assume that no major period effects related to policy intervention have been operative within our observation window.

Third, medical progress may improve population health and wellbeing. Our observation window covers two areas of major progress, improvements in neonatal care and improvements in the treatment of cardiovascular diseases (WHO 2015; Felder 2006). Both trends, however, are strongly age-graded, the former benefitting newborns, the latter benefitting older people. Therefore, we included more universal measures as factor characteristics in our models. First, we used a measure of yearly health expenditures as a share of GDP. This variable captures medical progress in a broader sense, including expenditures on the prevention of diseases, access to medical care, diagnostics, and treatments. This variable has frequently been used as an indicator of medical progress and is more consistent with the idea of a period effect, reflecting changes in expenditures across all age groups. In this regard, panel studies have shown that the relationship between age and health expenditures is weak (Zweifel et al. 1999).

Furthermore, we included a population measure of well-being. This measure is related to the utilization of and satisfaction with health care, and is considered a reliable indicator for subjective dimensions of changes in the quality of health care (Blumenthal et al. 2015). As a characteristic variable changes in wellbeing at population level, we used SOEP data on global life satisfaction measured on an 11-point Likert scale. Based on the entire sample of West German natives observed between 1992 and 2013 (N = 215,081 observations), we calculated an age-adjusted measure of average wellbeing for every year of our observation period. Due to refreshment samples, each of the SOEP waves can be considered a representative sample of the German population (Wagner et al. 2007).

Figure 2 illustrates year-to-year changes in all four factor characteristics. We conducted three additional tests in the multivariate models (results not shown) to ensure that the effects of our characteristic variables were specified appropriately. First, we tested the notion of period effects through interactions with age. As the effects of the characteristic variables remained largely unchanged, this test supported the notion of periodic influence. Second, we tested whether their effects differed across educational groups. We found no such interactions, increasing confidence that our estimates for educational differences in age and cohort effects were not biased by educational groups responding differently to periodic influence. Third, we tested different functions to represent potential effects of the characteristic variables on health. Based on these tests, we included unemployment rates in linear and quadratic form, and all remaining factor characteristics in linear form.

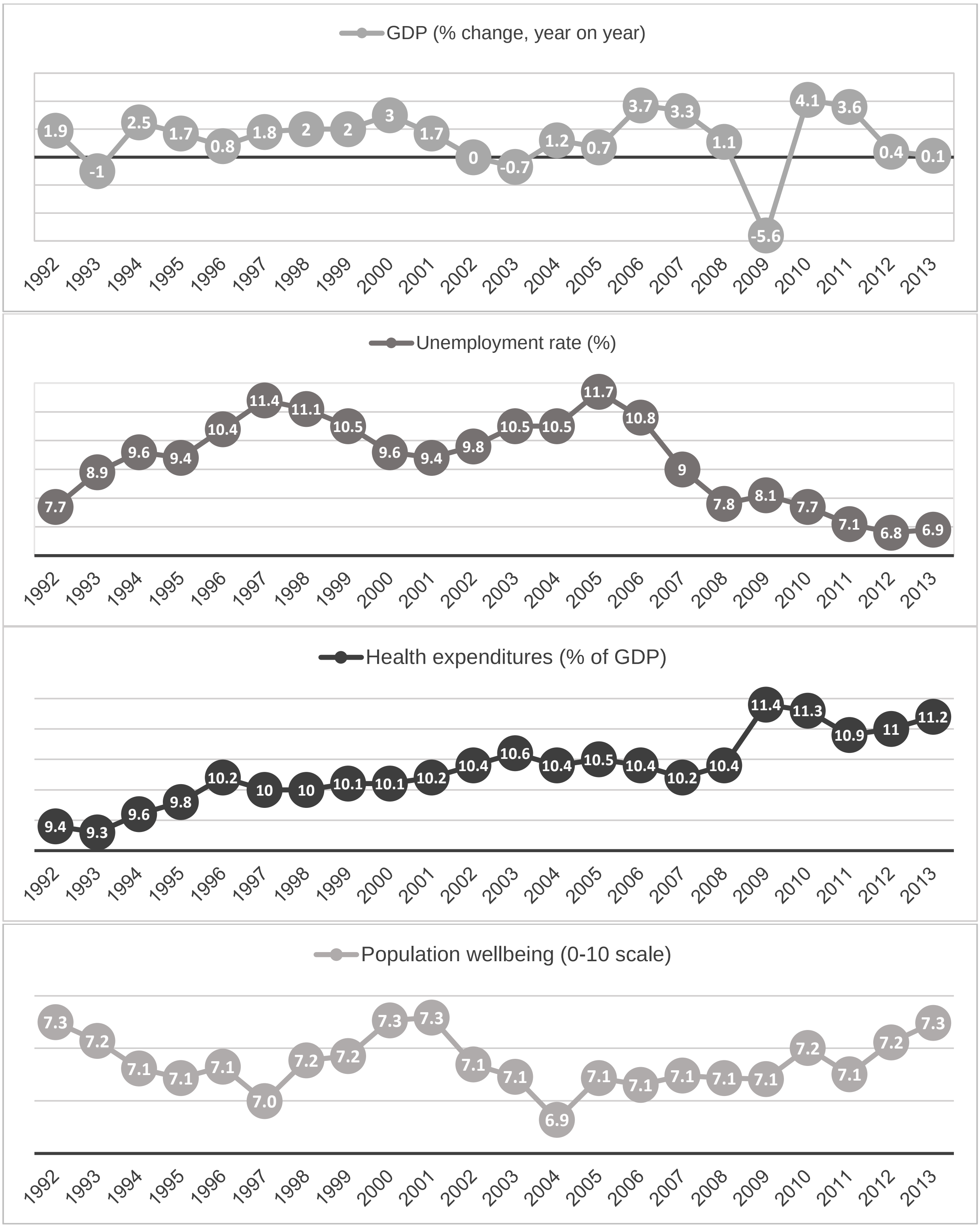

FIGURE 2. CHANGES IN FACTOR CHARACTERISTIC VARIABLES ACROSS THE OBSERVATION PERIOD

Data on GDP, unemployment rates, and health expenditures are from the Federal Statistical Office. Data on population wellbeing are from the SOEP samples of West German natives (*N* = 215,081 observations; authors' calculations).

Controls for dropout

To control for non-random dropout associated with poor health, we applied the method suggested by Chen, Yang, and Liu (2010), introducing direct controls for panel attrition. We constructed two time-constant indicator variables for whether respondents (a) had left the panel or (b) had died before the most recent wave of 2013. We included these controls to account for the possibility that later dropouts were in worse health compared to those remaining in the panel (Chen et al. 2010: 135). As shown in Table 2, nine percent of respondents selected in 1992 died across the observation period until 2012. Another 59% left the panel for other reasons. The average number of annual observations per respondent was 15.

Analytic strategy

We estimated change in SRH using hierarchical linear models (HLM) (Raudenbush and Bryk 2002). Our data included up to 21 observations per person, measured at yearly intervals. These repeated observations (level 1) were nested within persons (level 2). The HLM estimation accounts for heterogeneity in health trajectories, allowing individual age trajectories to differ in their starting levels (random intercepts) and rates of change (random slopes). The estimation of HLM provided information about mean health trajectories (growth curves) as well as individual variation around the average curves. The equations for the model are located in the Appendix.

Our main interest was in the effects of education on health trajectories. To test the hypotheses of cumulative (dis)advantage and rising importance, we assessed (a) whether these effects increased, decreased or remained constant with age and (b) whether these age patterns differed across cohorts. As discussed above, observed age patterns may be seriously biased if the cohort pattern is ignored, and vice versa (Lynch, 2003). This point is particularly relevant in the German context of the present study, as previous investigations were unable to model age and cohort effects appropriately: Data were either cross-sectional, thus precluding the separation of age and cohort effects (Schöllgen et al. 2010; Schmidt et al. 2012), or the analysis controlled for cohort but ignored potential interactions between age, cohort, and education (Becker 1998). As demonstrated by Lynch (2003), these incomplete specifications are very likely to produce statistical artifacts.

An appropriate analytical strategy to estimate change in the relationship between education and health is to account simultaneously for change with age, change across cohorts, and their interactions (Lynch, 2003; Willson et al. 2007; Mirowsky and Ross 2008). This approach translates into an empirical model that includes age, cohort, and education as well as two-fold and three-fold interactions between these variables.

We estimated three models to address these considerations for SHR (Models 1a, 2a, 3a) in the Table 3. The idea behind this sequence of models was to investigate the consequences of model specification for substantive conclusions regarding the hypotheses of cumulative (dis)advantage and rising importance. In particular, differences between the results yielded by each model enabled us to gain insight whether the lack of evidence for the cumulative (dis)advantage and rising importance hypotheses in previous analyses of the educational health gradient in Germany could be attributable to inadequate methodology.

We started from a simple cross-sectional model (OLS) estimating health in the year of 2002. We use the data from 2002 for this part of the analysis, 1) because previous German cross-sectional studies used data from the beginning of 2000s, and 2) because the PCS measure, which we use for a robustness check, was only available from 2002. This model (1a) resembled studies, which were unable to separate age and cohort effects in the cross-sectional estimation of educational health gradients (e.g., Schöllgen et al. 2010). In the second model, we turned to the longitudinal estimation (HLM), using repeated observations of health and introducing a control for cohort. This model (2a) corresponded to panel data analyses of health trajectories that considered cross-cohort variation in health but ignored interactions between age, cohort, and education (e.g., Becker 1998). The final growth curve model (3a) presents the complete specification, adding two-way and three-way interaction terms to the equation. .

Our main analysis is presented in the Tables 4 and 5. In these analyses, we take advantage of the exceptionally long time span at which data on self-rated health are available – from 1992 to 2014. This data allows not only to extensively analyze age trajectories of health, as it covers more than 20 years of individual life-courses, but also to detect cross-cohort patterns, as it allows for large age overlaps between cohorts. These advantages of the data come, however, at a cost, as period effects might become influential during such a long time span (Yang and Long 2013). In our main sets of models provided in the Table 4, we, thus, account for period effects. Moreover, although our data track individuals over an exceptionally long period of time, they do not cover the entire life courses of different birth cohorts. Hence, the basic model combines individual trajectories, which start and end at different ages into one extrapolated cohort to estimate change in health across the entire age range. Although cohort effects are modeled by interactions, differences can only emerge within the parametric constraints of a linear model. To overcome this restriction, we added a second analytical step in which we replaced the linear cohort variable by a categorical variable distinguishing between three cohort groups. This approach allowed to model flexible age trajectories within each cohort, and to account for non-linear patterns of change across cohorts. These results are shown in the Table 5.

As noted, there are strong theoretical reasons to expect gender differences in the extent to which processes of cumulative (dis)advantage have shape health trajectories, especially in the German context. To gain insight into such differences, we complemented the analysis by separate models for men and women.

Results

Results on the cumulative (dis)advantage hypothesis

Cross-sectional versus longitudinal modelling

Table 3 presents the results of each series of models for the analysis of SRH (Models 1a, 2a, 3a). The cross-sectional model (1a) largely reproduced previous German evidence. Those who had earned intermediate and high educational degrees scored considerably higher on each health measure than the low educated, signifying the expected health gap across levels of education. Contrary to the cumulative (dis) advantage hypothesis, however, these gaps did not widen across the life course, as indicated by the non-significant interaction terms between educational degrees and age. Consequently, the cross-sectional estimation suggested continuity in health trajectories across educational groups.

In the next models, we turned to the longitudinal estimation, controlling for cross-cohort differences in levels of health but ignoring possible interactions between cohort, age and education. Regarding cumulative (dis)advantage, findings remained unchanged for SRH (Model 2a), as the interaction terms did not indicate any widening of educational health gaps across the life course. Similar to the preceding models, these findings remained largely in line with previous evidence reported for Germany (Becker 1998). Note that the coefficient of the cohort control was positive for both outcomes, suggesting better health among older cohorts. Although this result appears counter-intuitive at first glance, it is consistent with U.S. findings and presumably reflects positive health selection of those entering the sample at more advanced ages (Willson et al. 2007; Mirowsky and Ross 2008).

Table 3: Hierarchical Linear models of self-rated health and physical component scale

	Self-Rated Health		
	Model 1a	Model 2a	Model 3a
Intercept	3.256***	2.959***	2.914***
	(0.018)	(0.025)	(0.035)
Age[a] (centered)	-0.016***	-0.032***	-0.044***
	(0.001)	(0.001)	(0.003)
Age squared (/100)	0.019***	-0.010**	-0.046***
	(0.006)	(0.003)	(0.009)
Intermediate education[b] (ref.: low)	0.124***	0.126***	0.151**
	(0.020)	(0.016)	(0.050)
High education[b] (ref.: low)	0.265***	0.287***	0.467***
	(0.023)	(0.019)	(0.060)
Intermediate education x Age	0.001	0.000	-0.000
	(0.002)	(0.001)	(0.003)
High education x Age	0.002	0.001	0.012***
	(0.002)	(0.001)	(0.003)
Cohort[c] (centered)		0.015***	0.017***
		(0.001)	(0.002)
Age x Cohort (/100)			0.054***
			(0.013)
Intermediate education x Cohort			-0.002
			(0.003)
High education x Cohort			-0.008**
			(0.003)
Interm. Education x Age x Cohort (/100)			0.016
			(0.010)
High education x Age x Cohort (/100)			-0.024*
			(0.012)
Variance components			
Residual (Level 1)		0.343***	0.343***
		(0.002)	(0.002)
Intercept		0.332***	0.330***
		(0.007)	(0.007)
Age		0.000***	0.000***
		(0.000)	(0.000)
Cov. of intercept and age		0.002***	0.002***
		(0.000)	(0.000)
Log Likelihood		-68,787	-68,765
Number of individuals	9,286	9,299	9,299
Number of observations	9,286	66,779	66,779

Notes: SOEP, release 2014, own calculations. Models control for gender and panel attrition due to nonresponse and death. [a]Centered on the grand median. [b] Low = CASMIN 1a-c (up to lower secondary vocational degree); intermediate = CASMIN 2a-c (up to higher secondary plus vocational training); high = CASMIN 3a-b (lower and higher tertiary). [c]Centered on the minimum age of sample entry, age 30 (i.e., birth cohort of 1972). *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.

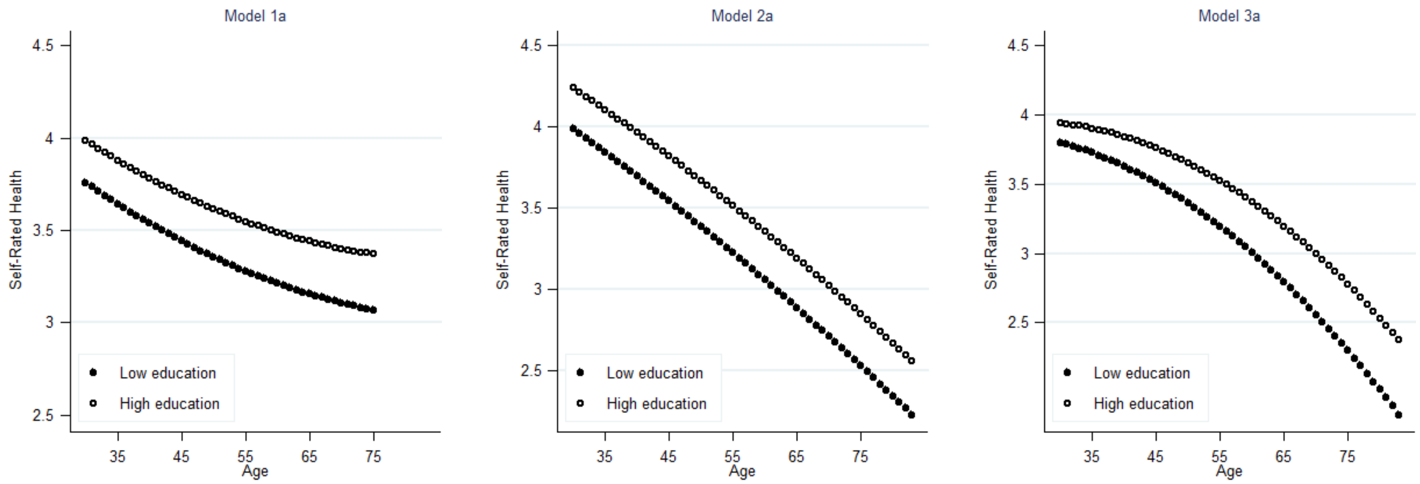

FIGURE 2: Predicted Trajectories of Self-Rated Health

SOEP, release 2013, own calculations. Predictions based on models models shown in Table 3. Low education = up to lower secondary vocational degrees (CASMIN 1a-c); high education = lower and higher tertiary degrees (CASMIN 3a-b); birth year fixed at 1952, gender set to male, remaining controls set to zero (i.e., no dropout).

In the final specification, any remaining evidence for persistent health trajectories was overturned. In Model 3a, controlling not only for cohort but also allowing for two-fold and three-fold interactions with age and education, the findings revealed divergence. Compared to Model 2a, the interaction effect between age and higher education found in Model 3a almost doubled.

Overall, the marked shifts from the previous models to the final specification are hardly surprising given that only the latter accounted for the – previously disregarded – fact that the health effects of education, age and their interaction unfold within specific cohort contexts which underwent profound changes over time.

A graphical representation of our first findings regarding the cumulative (dis)advantage is provided by the Figures 2, displaying predicted trajectories of SRH for lower and higher levels of education based on each of the models shown in Table 3. A comparison between the curves illustrates how incomplete model specification may yield biased estimates suggestive of persistent health trajectories. Under the full specification, health gaps between educational groups widened with age.

In Table 4 we present the results of the linear cohort model for the total sample (Model 1), and separately for the subsamples of men (Model 2) and women (Model 3). All models additionally control for period effects. The main effect of age pertains to the omitted category of lower educated people. The age slopes for intermediate and higher educated people are obtained by adding their interaction effects to this main effect. Positive interaction terms indicate that age slopes are flatter (i.e., health declines slower) in these groups. This is what the cumulative (dis)advantage hypothesis predicts.

Table 4: Hierarchical Linear models for self-rated health: Total Sample, Men, and Women

	Model 1: Total		Model 2: Men		Model 3: Women	
Intercept	3.190**	(0.022)	3.231**	(0.029)	3.224**	(0.028)
Age (median-centered)	-0.026**	(0.001)	-0.029**	(0.002)	-0.024**	(0.002)
Cohort (mean-centered) [a]	0.005*	(0.002)	0.006*	(0.003)	0.003	(0.003)
Education (ref.: Lower) [b]						
Intermediate	0.182**	(0.025)	0.185**	(0.037)	0.171**	(0.034)
Higher	0.302**	(0.032)	0.327**	(0.040)	0.279**	(0.052)
Age x Cohort (/100)	0.006	(0.008)	0.017	(0.012)	-0.008	(0.011)
Age x Education						
Age x Intermediate	0.000	(0.002)	0.002	(0.002)	-0.001	(0.002)
Age x Higher	0.005**	(0.002)	0.012**	(0.003)	-0.003	(0.003)
Cohort x Education						
Cohort x Intermediate	0.003	(0.002)	0.006	(0.004)	0.003	(0.003)
Cohort x Higher	-0.006	(0.003)	-0.012**	(0.004)	0.003	(0.005)
Age x Cohort x Education						
Age x Cohort x Intermediate (/100)	-0.016	(0.013)	-0.004	(0.020)	-0.016	(0.017)
Age x Cohort x Higher (/100)	-0.052	(0.017)	-0.020	(0.022)	0.022	(0.029)
Male	0.071**	(0.020)				
Period controls (all mean-centered)						
Unemployment rate	-0.130**	(0.026)	-0.160**	(0.037)	-0.102**	(0.037)
Unemployment rate squared	0.006**	(0.001)	0.008**	(0.002)	0.005*	(0.002)
GDP	-0.003	(0.002)	-0.002	(0.002)	-0.004	(0.002)
Population wellbeing	0.100**	(0.029)	0.077	(0.041)	0.121**	(0.041)
Health expenditures	-0.027*	(0.014)	-0.042*	(0.020)	-0.014	(0.020)
Variance components						
Residual (Level 1)	0.353**		0.334**		0.370**	
Intercept	0.361**		0.367**		0.355**	
Age	0.001**		0.001**		0.001**	
Covariance of intercept and age	0.003*		0.003*		0.002*	
N (observations)	63,889		30,858		33,031	

SOEP, release 2014. Standard errors in parentheses. All models control for panel attrition due to nonresponse and death. [a]Centered on the mean age of sample entry, age 41 (i.e., birth cohort of 1951). [b]Lower = CASMIN 1a-c (up to lower secondary vocational degree); intermediate = CASMIN 2a-c (up to higher secondary plus vocational training); higher = CASMIN 3a-b (lower and higher tertiary). p < 0.01, * p < 0.05.

In Model 1, pertaining to the full sample, the interactions between age and education show that health declines were slower among higher educated people. This is the aggregate-level pattern of health trajectories that is commonly associated with the cumulative (dis)advantage hypothesis. It contradicts the results of previous cross-sectional studies from Germany (Knesebeck 2005; Schöllgen et al. 2010). Next, we addressed gender differences in separate models for men (Model 2) and women (Model 3). Compared with the full sample, the interaction effect between age and higher education more than doubled in size among men and was absent among women.

Figure 2 illustrates the results for the full sample (left-hand panel), the subsample of men (middle panel), and the subsample of women (right-hand panel). Each graph shows predicted trajectories of SRH for higher and lower educated individuals. The curves pertain to the cohort of 1951, as we fixed all covariates at their means. A comparison between the three graphs shows that divergence with age emerged as the overall pattern only because this effect was so strong among men. In the subsample of women, educational gaps in health even narrowed with age, although this convergence was slight and statistically insignificant. Importantly, the absence of divergence in women was due to faster health declines among higher educated women compared to those of higher educated men.

Within the subsample of men, the educational health gap widened at a rapid pace. To evaluate the size of this effect, we compared the ages at which educational groups are expected to cross the level of “acceptable” health (i.e., descending below the value of 3). Among lower educated men, this occurred around the age of 60; among higher educated men, in their mid-80s – approximately twenty-five years later in life.

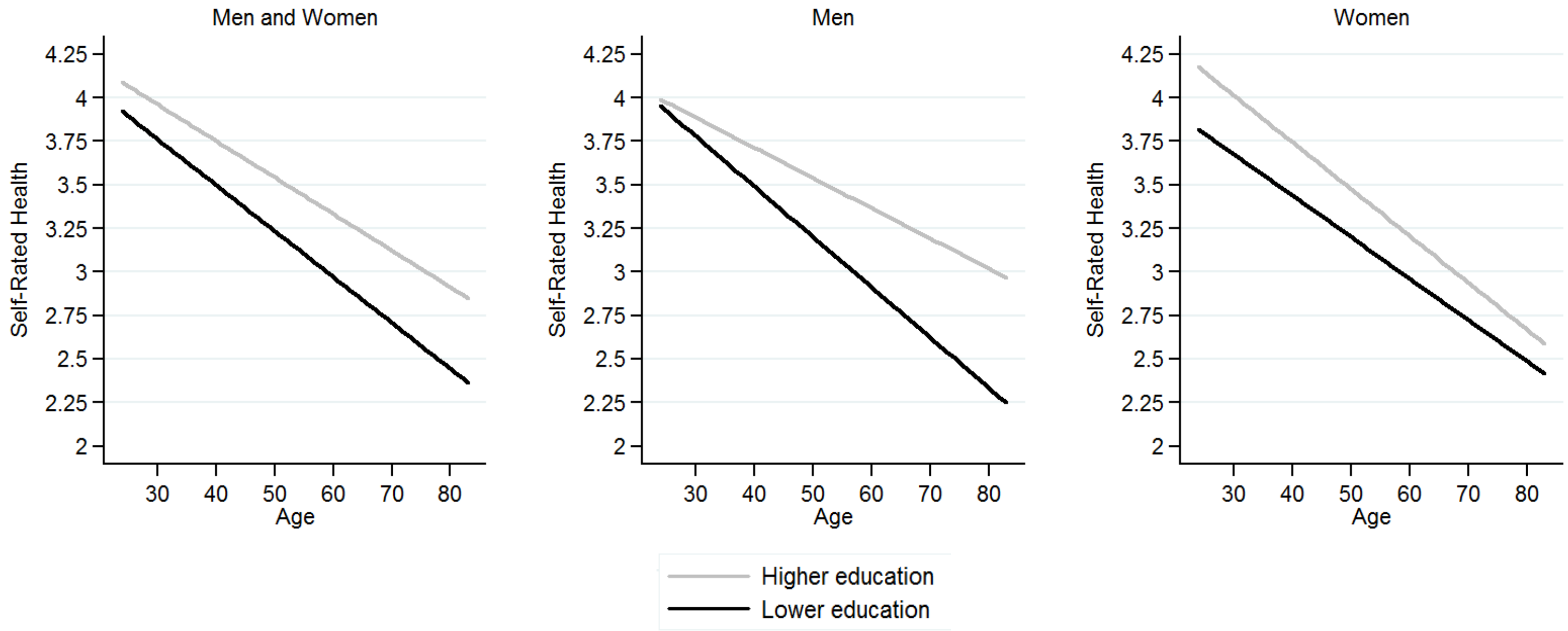

FIGURE 3: PREDICTED TRAJECTORIES OF SELF-RATED HEALTH: FULL SAMPLE, MEN, AND WOMEN

SOEP, release 2014. Predictions based on Model 1(full sample) Model 2 (male subsample) and Model 3 (female subsample). See Table 3 for details on the estimation. Cohort centered at 1951, remaining covariates fixed at their means. Lower education = up to lower secondary vocational degrees (CASMIN 1a-c). Higher education = lower and higher tertiary degrees (CASMIN 3a-b).

Results on the rising importance hypothesis

For a test of the rising hypothesis, the focus is on cross-cohort change in the interactions between age and education. This change is indicated by a three-way interaction between age, education, and cohort. In the models shown in Table 5, the two-way interactions between age and education are defined for the centered cohort variable equaling zero (i.e., for the cohort of 1951). In our specification, higher values of the cohort variable indicate older cohorts. Consequently, negative three-way interactions with cohort would indicate that cumulative (dis)advantage of education for health is less pronounced in older than in younger cohorts. This is what the rising importance hypothesis predicts.

Next, we turn to the second guiding hypothesis, which postulated a rising importance of education for health. Although Model 3 did not indicate divergence among women, these results do not necessarily contradict the rising importance hypothesis, as a linear cohort model might suppress a trend that emerges only among the most recently born. Therefore, we examined women's health trajectories separately for the four cohort groups, but we found no divergence in any cohort group and generally no substantial cohort differences among women (results not shown). Overall, our results for women were inconsistent with both the hypotheses of cumulative (dis)advantage and of rising importance.

For men, in contrast, both hypotheses were supported. In Model 2, the two-way interaction between high education and cohort was negative, indicating that educational health gaps at the median age of 49 were slightly smaller in older cohorts. Furthermore, the negative sign of the three-way interaction between age, high education, and cohort was consistent with the rising importance hypothesis, indicating that health gaps increased more slowly in older cohorts of men.

TABLE 5: HIERARCHICAL LINEAR MODELS FOR SELF-RATED HEALTH: THREE COHORTS OF MEN

	Model 4	
Intercept		
Age [a]	-0.022**	(0.002)
Cohort (ref.: Pre-War & War)		
Post-War	0.229**	(0.056)
Baby Boom	0.562**	(0.055)
Education (ref.: Lower) [b]		
Intermediate	0.261**	(0.075)
Higher	0.136	(0.075)
Age x Cohort		
Age x Post-War	-0.010**	(0.002)
Age x Baby Boom	-0.007**	(0.002)
Age x Education		
Age x Intermediate	-0.002	(0.003)
Age x Higher	0.009**	(0.003)
Cohort x Education		
Post-War x Intermediate	-0.123	(0.102)
Baby Boom x Intermediate	-0.214*	(0.094)
Post-War x Higher	0.041	(0.107)
Baby Boom x Higher	-0.031	(0.098)
Age x Cohort x Education		
Age x Post-War x Intermediate	0.008*	(0.004)
Age x Baby Boom x Intermediate	0.004	(0.004)
Age x Post-War x Higher	0.004	(0.004)
Age x Baby Boom x Higher	0.004	(0.004)
Period controls (all mean-centered)		
Unemployment rate	-0.173**	(0.038)
Unemployment rate squared	0.009**	(0.002)
GDP	-0.003	(0.002)
Wellbeing	0.087*	(0.042)
Health expenditures	-0.051**	(0.019)
Variance components		
Residual (Level 1)	0.356**	
Intercept	0.368**	
N (observations)	30,858	

SOEP, release 2014. Standard errors in parentheses. All models control for panel attrition due to nonresponse and death. [a]Centered on the cohort-specific minimum ages (47 in the Pre-War & War cohort, 36 in the Post-War cohort, 24 in the Baby Boom cohort).
[b]Lower = CASMIN 1a-c (up to lower secondary vocational degree); intermediate = CASMIN 2a-c (up to higher secondary plus vocational training); higher = CASMIN 3a-b (lower and higher tertiary). ** $p < 0.01$, * $p < 0.05$.

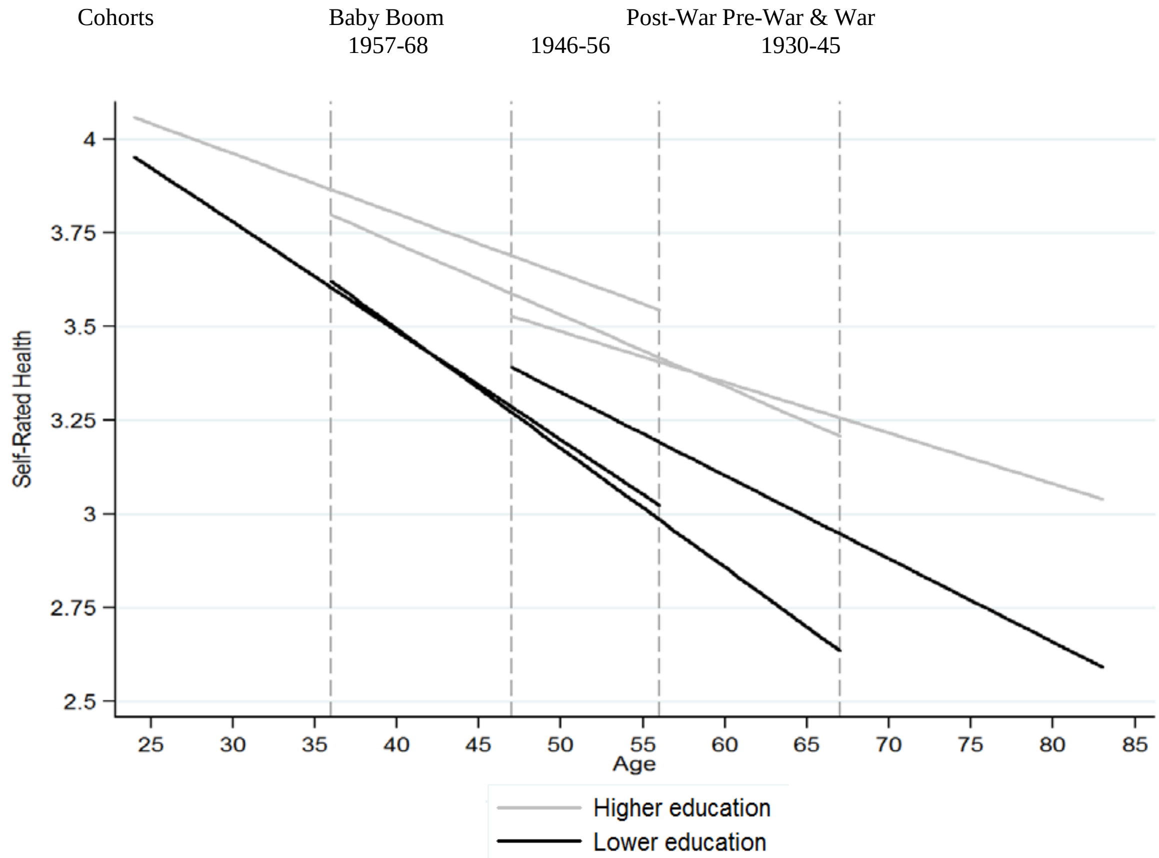

FIGURE 4: PREDICTED TRAJECTORIES OF SELF-RATED HEALTH IN THREE COHORTS OF MEN

SOEP, release 2014. Predictions based on Model 4, Table 4. Age centered at cohort-specific minimum values (47 in the Pre-War & War cohort, 36 in the Post-War cohort, 24 in the Baby Boom cohort), other covariates fixed at their means. Vertical dashed lines indicate lower and upper boundaries of age overlaps between cohorts (see Table 5). Lower education = up to lower secondary vocational degrees (CASMIN 1a-c). Higher education = lower and higher tertiary degrees (CASMIN 3a-b).

As noted, the models shown in Tables 3 and 4 are limited in capturing only linear change across cohorts. In Table 5, we examine the rising importance hypothesis in more detail, comparing health trajectories of pre-war and war cohorts to post-war cohorts and baby boom cohorts of German men. For ease of interpretation, we illustrate the key findings from Table 4 in two ways. First, we plot the curves derived from this model in Figure 4. The figure shows the large overlaps between age and cohort, which allow us to disentangle their effects. Second, based on these predicted trajectories, we calculated health gaps at the lower and upper bounds of age overlaps between the three cohort groups. Table 5 shows these health gaps, measured in scale points of SRH, at each of these overlapping ages. The rows of Table 5 pertain to cumulative (dis)advantage, showing age-related increase of health gaps within each cohort; the columns pertain to rising importance, showing cross-cohort change in the size of these gaps measured at overlapping ages.

TABLE 6: HEALTH GAPS BETWEEN HIGHER AND LOWER EDUCATED MEN AT OVERLAPPING AGES

Cohort	Health Gaps Between Higher and Lower Educated Men at Age			
	36	47	56	67
Pre-war & war 1930-45		0.14	0.21	0.31
Post-war 1946-56	0.18	0.32	0.43	0.57
Baby boom 1957-68	0.26	0.40	0.52	

SOEP, release 2014. Predictions are based on Model 4, Table 4. Gaps are measured as absolute differences in scale points of self-rated health (*SD* of within-person change over time in self-rated health is 0.61). See Figure 4 for a graphical illustration of health gaps.

With regard to the rising importance hypothesis, Figure 4 and Table 6 show three notable patterns. First, health trajectories between lower and higher educated men diverged in every cohort. Second, in line with the rising importance hypothesis, health gaps increased across cohorts. Gaps measured at the age of 56, for example, more than doubled from approximately 0.2 scale points in the oldest cohorts to more than 0.5 scale points in the youngest cohorts (Table 6). Third, this trend was primarily produced by steeper health declines among the lower educated. Lower educated men who belonged to the post-war and baby boom cohorts fell below the level of "acceptable" health already in their mid-fifties. In the oldest cohort of lower educated men, this occurred approximately ten years later in life (Figure 4). Age slopes of higher educated men changed little across cohorts. Overall, these findings lend qualified support to the rising importance hypothesis, suggesting that the rate of cumulative (dis)advantage accelerated among men born in the post-war years, and that this shift was centered around the lower educated who experienced steeper health declines.

Finally, we turn to the period controls included in all models. Overall, the results indicated that periodic influence on health was minor, although the negative effects of unemployment and the positive effects of wellbeing were statistically significant in all models. For example, shifting unemployment from its minimum (6.8 % in 2012) to its maximum (11.7% in 2005) involved an average drop of only 0.05 scale points in SRH (Model 1). An analogous increase from the empirically observed minimum of wellbeing (6.9 in 2004) to its maximum (7.3 in 2014) was associated with a rise of only 0.04 scale points in SRH. The remaining period effects were even smaller.

Attrition analyses

In additional analyses, we examined the extent to which selective panel dropout and mortality might affect our results. Descriptive results on these analyses are shown in Table A1 in the Appendix. As expected, mortality was higher among lower educated than among higher educated men. Among lower educated men 17.4 % died across the observation period; among higher educated men, 4.6% died. Among women 9.8% of the lower educated and 4% of the higher educated died. However, only very few deaths (n = 82 or 18% of all deaths) occurred before the age of 54 – the highest age at which all four cohorts overlap. Second, the chance of dying before this age barely differed between educational groups. This indicates that our conclusions about cohort differences observed at overlaps up to this age are unlikely to be affected by selective mortality. Furthermore, we examined whether panel dropout for reasons other than death differed across levels of education. These analyses showed, first, that dropout rates were similar for lower and higher educated respondents, and, second, that baseline levels of health (i.e., at initial observation in 1992) did not differ between those who later dropped out of the panel and those who stayed in the panel until the last observation in 2014. These findings suggest that panel dropout was unlikely to bias the health trajectories found for different educational groups.

U.S. research has suggested that older respondents might still constitute a selective group already at the start of our observation period in 1992. Because a substantial proportion of our sample had been recruited already in 1984, our data allowed us to test whether selection into our initial sample was related to health and education. To explore this possibility, we followed the procedure suggested by Willson and colleagues (2007), calculating a propensity score for respondents who had been initially recruited by the SOEP in 1984 and estimating a logistic regression model, which predicted inclusion of individuals from the oldest cohort in the analytic sample of 1992. Predictor variables included education, age and various indicators for health such as satisfaction with health, doctor and hospital visits, sickness absence, and disability. Respondents from the oldest cohort were aged between 39 and 54 at panel entry in 1984 – an age range at which selection due to health problems is unlikely. Unlike in the analysis of Willson and colleagues (2007), the chance of sample inclusion was not related to health in 1984; neither did inclusion of the propensity score alter the effect of education on health, net of other controls for dropout. These results suggest that selection processes prior to the anchor year of 1992 were unlikely to affect our results.

Discussion

According to cumulative (dis)advantage theory, health gaps between social groups emerge from broader patterns of social inequality. Education plays a central role in this process, reproducing initial social disparities and shaping health trajectories as people age. A key tenet of this perspective is the expectation of widening health gaps between educational groups over the life course.

In recent years, tests of the cumulative (dis)advantage hypothesis have been refined by greater attention to the social conditions in which individual health trajectories unfold. This line of research has not only led to methodological progress but also spawned new theoretical perspectives. These include the rising importance hypothesis, which predicts cumulative (dis)advantage to intensify across cohorts, and competing hypotheses about gender differences, suggesting that cumulative (dis)advantage is a gendered phenomenon.

Despite these recent advances, the context-specific nature of cumulative (dis)advantage is still not widely recognized, either theoretically or empirically. In the present study, we addressed three gaps of research. First, cumulative (dis)advantage theory has been limited by an individual, rather than contextual, focus on the core association between education and health. In this study, we explicated a theoretical framework that considers individual change with age and socio-historical change across cohorts as well as gender differences and cross-national differences in these processes.

Second, empirical research on cumulative (dis)advantage of education for health has been limited by a focus on the U.S., precluding insight that can be gained from variation in national context. In this study, we introduced this variation, using German data and viewing cumulative (dis)advantage through a comparative lens to gain further insight into structural forces shaping health inequality across lives and cohorts.

Third, most analyses that have aimed to disentangle age and cohort effects on health are limited by short observation windows, yielding little overlap between age and cohort, or insufficient attention to periodic influence, potentially biasing the estimates for age and cohort effects. In this study, we used an observation window of unprecedented range and we introduced a theoretically motivated factor characteristic model to control for period effects.

Our comparative theoretical framework highlighted differences between Germany and the U.S. in the structural forces of inequality shaping various health-relevant factors on which the hypotheses of cumulative (dis)advantage and rising importance are based. These include the role of the educational system in reproducing initial advantages and disadvantages related to social origin and stratifying economic outcomes in later life; the role of the welfare state in targeting the steady increase of educational disparities in health-related resources over the life course; change over time in the distribution of health-relevant resources and the composition of educational groups; and the gendered structure of the life course differentially exposing men and women to the risk factors driving processes of accumulation.

Our empirical analyses examined health inequality over the adult life course in Germany, offering the first empirical assessment of the cumulative (dis)advantage and rising importance hypotheses in this context. The divergent health trajectories found in this investigation are inconsistent with previous studies of health inequality in Germany. These studies reported health gaps to remain stable (Schöllgen et al. 2010) or to converge with age (Schmidt et al. 2012) and attributed these patterns to compensatory effects of relatively generous welfare benefits, employment protection, and nearly universal access to health care (Knesebeck et al. 2003; Knesebeck 2005). As demonstrated by the present study, however, these conclusions might change if the data allow the disentangling of age and cohort effects. In this regard, our model comparisons showed that seemingly persistent age patterns revealed their true (i.e. divergent) character only if cohort effects and their interactions with age and education were taken into account.

Compared with the U.S., our results revealed two further notable differences. First, empirical support for the cumulative (dis)advantage hypothesis was limited to health trajectories in men. Among women, we found no evidence for cumulative (dis)advantage, as the rates of health decline did not differ between the higher and the lower educated. Women did not translate higher education into slower health declines, whereas men reaped these benefits throughout all major stages of the adult life course. These results contrast sharply with U.S. findings indicating that cumulative (dis)advantage not only pertains to both sexes, but is stronger among women (Ross and Mirowsky 2010; Pudrovska 2014).

We argued that critical links between education and health – in particular labor market factors and health behaviors – are tighter among men than among women in Germany. Moreover, women's resources in our study cohorts were largely determined by their partners' socioeconomic status, potentially weakening the relationship between women's education and health. Due to hypergamy, however, this argument would suggest slower health declines among lower educated women rather than faster health declines among higher educated women. Our data showed the opposite pattern.

We can only speculate about why higher educated women did not benefit from their education as much as men did. One possible reason are labor market and partner market disadvantages compared to German men. First, higher educated women of our study cohorts had lower chances of attaining higher occupational positions and incomes (Sørensen and Trappe 1995). Second, unlike their lower educated counterparts, they were less likely to marry and to reap associated benefits such as economies of scale and within-household compensation for individual labor market disadvantages (Blossfeld and Tim 2003).

Although our results on women contradict the common interpretation of the cumulative (dis)advantage hypothesis, they do not imply that the mechanism of cumulative (dis)advantage was absent in women. For example, higher educated women were in better health than lower educated women already early in life and kept this advantage across the life course. This may indicate that higher educated women accumulated health-related advantages early in life (i.e., before our starting age of 23). Alternatively, health selection into education may explain why gaps among women emerged so early. A further possibility concerns gender-specific responses to our outcome measure of self-rated health. Research has shown that men and women might evaluate their health differently (Benyamini et al. 2003). Moreover, research from the U.S. has shown educational differences in the reliability of self-rated health measurements (Zajacova and Dowd 2011). In light of these limitations of our outcome measure, a replication of our analysis on the basis of more objective health measures could shed more light on gender differences in health trajectories.

In research on health inequality, theoretical formulations and empirical tests of the cumulative (dis)advantage hypothesis have often ignored the possibility of gender differences (Kim 2008; Kim and Durden 2007; Lynch 2003; Mirowsky and Ross 2008; Willson et al. 2007). Our findings show that attention to such differences is warranted, particularly in studies that examine whether evidence from the U.S. can be generalized to other societies. The opposing patterns found for the U.S. and Germany point to the role of structural forces that have differentially shaped health trajectories of men and women in these societies.

With regard to the rising importance hypothesis, our results also contrast with those obtained for the U.S. context. The cohort pattern of increasing divergence was limited to men and attributable to steeper health declines among lower educated men from younger cohorts. We found no cross-cohort differences among higher educated men. In the U.S., the rising importance of education for health emerged as a combined outcome of slower health declines among the higher educated accompanied by faster health declines among the lower educated (Mirowsky and Ross 2008).

Again, these differences highlight the potential for comparative research, showing how health trajectories are differentially shaped by the context in which they unfold. In Germany, changes in returns to education and compositional change in health-relevant characteristics were negligible among higher educated men. The lower educated, in contrast, became more negatively selected and faced substantial declines in educational returns (Solga 2002). In the U.S., increasingly adverse conditions among the lower educated were accompanied by increasingly favorable conditions among the higher educated (Hout 2012). These cross-national differences are broadly consistent with our findings on the rising importance hypothesis. We note, however, that more precision is necessary in future comparative research to unravel whether, and to what extent, the proposed mechanisms have produced the observed patterns.

Considering the rising importance hypothesis, we further note that although processes of cumulative (dis)advantage have spared our study cohorts of women, this might change among the more recently born. Especially among women born in the 70s and 80s, education became more relevant to various life course outcomes. Examples are the narrowing gender gap in labor force participation, women's increasing economic returns to education (Fitzenberger and Wunderlich 2003), and growing differences in risky health behaviors such as smoking (Schulze and Mons 2006). Moreover, the proportion of higher educated women surged upward in these cohorts, whereas the group of lower educated women shrank, suggesting increasingly negative selection on health-relevant characteristics. In view of these shifts, we consider it important to explore whether processes of cumulative (dis)advantage of education for health have commenced among more recent cohorts of German women.

In future studies of cumulative (dis)advantage and rising importance, the adequate separation of age and cohort effects – both theoretically and empirically – remains an important analytical challenge. In this regard, the present study has contributed not only on theoretical but also on methodological grounds. First, in following a large range of study cohorts over an observation period spanning more than two decades, our data were ideally suited to test theoretical ideas about non-linear cohort effects. Given the extensive overlap between age and cohort in these long-run panel data, our analysis no longer relied on the assumptions of a synthetic cohort model (e.g., Mirowsky and Ross 2008). As equally rich panel data about health currently become available in other countries, we expect that novel insight can be gained from future tests of both hypotheses.

Second, as longer observation periods give rise to period effects, we have offered the first comprehensive treatment of the age-period-cohort problem in the study of cumulative (dis)advantage and rising importance. Our factor characteristic model posited, first, that only a few factors may shape health regardless of age, and second, that those factors can be measured directly. Findings on the period controls for economic shifts and medical progress showed that across our observation window (1992 until 2014), period effects on health were relatively weak. Moreover, these effects did not differ across educational groups, and inclusion of the period controls did not alter the estimates for age, cohort, and their interactions with education. These findings increase confidence that period effects, even if uncontrolled, are unlikely to bias estimates for cumulative (dis)advantage and rising importance.

This conclusion, however, is preliminary and limited in scope. It is based on the assumption that our model included all theoretically relevant factors and measured those factors adequately. Furthermore, it cannot be generalized to other observation periods and to other societies, although our theoretical and empirical rationale to evaluate period effects is more widely applicable. Depending on this evaluation, analysts could maintain the assumption of no period effects (Willson et al. 2007), introduce factor characteristics (Winship and Hardy 2008; O'Brien 2015), or estimate constrained models to achieve identification (Yang and Land 2013; Bell and Jones 2014).

Looking at the overall picture of current life course research on health inequality, this study's theoretical perspective and empirical results suggest that cumulative (dis)advantage of education for health is a context-specific phenomenon rather than a universal principle. As other comparative evidence remains scarce (Chen et al. 2010; van Kippersluis et al. 2010), future research along these lines holds great potential to advance our understanding of health inequality across lives and cohorts. Considering the vast cross-national differences in social stratification and welfare state intervention, inclusion of other country contexts can provide new answers to important questions: Under which conditions do social disparities in health accumulate faster or slower? What types of welfare state intervention may break the chains of accumulation?

It appears worthwhile to look at the egalitarian regimes of northern Europe in future tests of cumulative (dis)advantage and rising importance. Compared to Germany and the U.S., these countries offer more generous social policies and more equal chances in the educational and occupational systems, potentially offsetting any accumulation of health inequality over the life course (DiPrete 2002). In cross-sectional assessments, however, these countries have revealed sizable health gaps across various measures of socioeconomic position (Mackenbach 2012). These findings, currently discussed as the "Nordic paradox", might constitute a fruitful research problem to address on the basis of longitudinal data that will allow disentangling age and cohort effects. As these data are now available in many countries, studies along these lines will shed more light on processes of cumulative (dis)advantage and rising importance to help resolve the remaining puzzles of research on health inequality.

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Appendix

The growth curves for self-rated health (SRH) of respondent *i* at time *t* are as follows (see Willson et al. 2007):

Level 1:

(1)

$$SRH_{ti} = \pi_{0i} + \pi_{1i} age_{ti} + \pi_{2i}\ period\ controls_{ti} + e_{ti}$$

$i = 1, \ldots, N$ persons in the sample,
π_{0i} is an individual-specific intercept,
π_{1i} is the growth rate for person *i*.

The model estimates effects of individual characteristics on the intercepts (π_{0i}) and slopes π_{1i} of Level-1 variables:

Level 2:

(2)

$$\pi_{oi} = \beta_{00} + \beta_{01}\ intermediate\ education_i + \beta_{02}\ high\ education_i + \beta_{03}\ cohort_i + \beta_{04}\ cohort_i\ x\ intermediate\ education_i + \beta_{05}\ cohort_i\ x\ high\ education_i + \beta_{0q}\ dropout\ controls_i + r_{0i}$$

,

$$\pi_{1i} = \beta_{10} + \beta_{11}\ intermediate\ education_i + \beta_{12}\ high\ education_i + \beta_{13}\ cohort_i + \beta_{14}\ cohort_i\ x\ intermediate\ education_i + \beta_{15}\ cohort_i\ x\ high\ education_i + r_{1i}$$

β_{pq} are the effects of individual characteristics on intercept π_{oi} and slope π_{1i},
r_{pi} are error terms for unmeasured time-constant characteristics of individual *i*.

Combining (1) and (2) yields the following equation for our models shown in Table 3:

(3)

$$SRH_{ti} = [\beta_{00} + \beta_{10} age_{ti} + \beta_{01}\ intermediate\ education_i + \beta_{02}\ high\ education_i + \beta_{03}\ cohort_i + \beta_{04}\ cohort_i\ x\ intermediate\ education_i + \beta_{05}\ cohort_i\ x\ high\ education_i + \beta_{0q}\ dropout\ controls_i + \beta_p\ period\ controls_{ti} + \beta_{11}\ age_{ti}\ x\ intermediate\ education_i + \beta_{12}\ age_{ti}\ x\ high\ education_i + \beta_{13}\ age_{ti}\ x\ cohort_i + \beta_{14}\ age_{ti}\ x\ intermediate\ education_i\ x\ cohort_i + \beta_{15}\ age_{ti}\ x\ high\ education_i\ x\ cohort_i] + [e_{ti} + r_{0i} + r_{1i} age_{ti}]$$

.

TABLE A1: ATTRITION ANALYSIS

	Lower education			Higher education		
	Died	Left	Stayed	Died	Left	Stayed
Year of birth (*M*)	1940	1951	1949	1942	1955	1954
Male (%)	64	47	48	70	69	63
Self-rated health in anchor year (*M*)	3.02	3.51	3.42	2.97	3.92	3.91
Number of panel observations (*M*)	12.5	10.7	22.8	13.3	10.8	22.8
n	333	1,351	772	33	425	293
% of total *N*	16	55	31	4	56	39
Total *N*		2,456			751	

SOEP, v. 31.1, release 2016.

Chapter V

Discussion

Life course processes are shaped by “the opportunities and constraints of history and social circumstances” (Elder 1998: 961–962). In line with this premise, research has shown that health inequality increases over the life course and that this pattern has intensified across cohorts. Although the importance of context is increasingly recognized, theoretical and empirical work on health inequality over the life course was largely limited to the United States. This limitation is important, given that a cross-national comparative perspective introduces much stronger variation in contextual factors than a cross-cohort perspective on the United States (Herd 2016). The present dissertation addressed this limitation, investigating health inequality across lives and cohorts in Sweden, the U.S., and West Germany.

Sweden and Germany contrast sharply with the U.S. not only regarding the size of socioeconomic disparities in health, but also regarding their life-course and cross-cohort profiles. My results suggest that life-course and cross-cohort trajectories of socioeconomic disparities in health are highly context-specific and cannot be generalized across countries. For example, I found that in Sweden, socioeconomic disparities in health in were small, increased only moderately with age, and remained stable across cohorts. In Germany, educational gaps in health widened with age and across cohorts, but these findings pertained only to men. In the U.S., educational differences in health widened with age and across cohorts among men and particularly among women.

The main theoretical contribution of my dissertation was in explicating a theoretical framework for individual and contextual influences on the core association between socioeconomic position and health. In this framework, I viewed cumulative (dis)advantage (a) from a life course perspective considering individual age-related change, (b) from a cohort perspective considering socio-historical change, (c) from a comparative perspective considering cross-national differences, and (d) through a gendered lens considering how structural forces may differentially shape men's and women's health across their life courses. This framework situated the cumulative (dis)advantage hypothesis within the context in which individual life course unfold and showed how this processes stipulated by this hypothesis depend on institutional settings and social policy. Although my findings indicate that the forces of cumulative (dis)advantage are powerful in stratifying health along social-economic lines throughout the life course, they also suggest that the process of cumulative (dis)advantage can be slowed down or possibly even offset.

One implication is that the validity of the arguments behind the cumulative (dis)advantage hypothesis must be adapted not only regarding the historical context, but also regarding the institutional context that differs across countries. Regarding single-country analyses, the findings of the present dissertation suggest that greater attention should be devoted to subgroups within socioeconomic strata, such as gender, immigrant status, and race. Tendencies in this direction are already recognizable in the most recent U.S. studies on cumulative (dis)advantage, which incorporate multiple interactions between socioeconomic position, gender, and race (Pudrovska 2014; Brown et. al 2016).

With respect to between-country comparisons, my theoretical framework covered only three countries. Future research should extend this framework and apply it to further meaningful comparative contrasts. For instance, I compared contexts that differ sharply from the U.S. regarding each of the arguments behind the cumulative (dis)advantage hypothesis. A fruitful further step might be to examine socioeconomic health inequality across lives and cohorts in contexts that are more similar to the U.S., such as other liberal economies.

The empirical contribution of my dissertation is threefold. I conducted (a) the first test of the cumulative (dis)advantage hypothesis in the Swedish context, (b) the first directly comparative test of the cumulative (dis)advantage hypothesis in the U.S. and Sweden, and (c) the first longitudinal test of the cumulative (dis)advantage hypothesis in the German context. Using large-scale longitudinal data and applying state-of-the-art statistical techniques, my dissertation has advanced knowledge in these three domains and, more generally, on the cumulative (dis)advantage process. It has provided insight into how socioeconomic disparities in health outcomes are shaped by life-course and cross-cohort processes within the Swedish and West German contexts as well as into the potential of cross-national comparisons in the analysis of these processes.

A number of limitations of the present dissertation warrant future investigation. First, from my theoretical framework I derived only general expectations regarding age and cohort effects on socioeconomic disparities in health. More specific comparative hypotheses can be derived from this framework in future studies. For example, I argued that inequality in economic means and health behaviors increases more strongly over the life course in the United States than in Sweden. Once comparative long-term panel data on earnings and health behaviors are available, it will be possible to investigate empirically whether these trends explain the smaller increase in educational health gaps in Sweden as compared to the U.S.

Second, my theoretical framework focused only on the broad arguments of the cumulative (dis)advantage hypothesis. Mechanisms that produce particular patterns of socioeconomic disparities over the life-course are more complex. Epidemiological research has specified mechanisms such as the "'long arm' of childhood conditions," the "critical period," "cumulative exposure," "turning points," and path-dependent "chains of risks" that operate throughout each life stage and translate into chronic diseases and other health problems later in life (Ben-Shlomo and Kuh, 2002; Kuh, Ben-Shlomo, Lynch, Hallqvist, and Power, 2003). This line of research has investigated how these mechanisms generate differential health outcomes between social groups, usually measured at one point in time – most commonly in later life (Guralnik, Butterworth, and Kuh, 2006; Kim, 2011; Luo and Waite, 2005; Warren, 2009). Recent research has attempted to test whether these mechanisms explain the shape of health trajectories (Ferraro et al. 2015). However, most studies on cumulative (dis)advantage, including my own, have not engaged with such mechanisms either theoretically or empirically. This is a promising area of novel research that has the potential to identify more specific triggering mechanisms causing an acceleration of socioeconomic differences in health over the life course. Once such triggers are discovered, social policy may develop more targeted interventions in order to slow down such developments.

Third, I mainly focused on education as a measure of socioeconomic position. Inclusion of other indicators of socioeconomic position could provide additional insights into the processes that generate cumulative (dis)advantage in health. In this regard, a number of studies have shown that different measures of social position differentially related to measures of health and mortality. For example, studies have shown that education is more predictive of diabetes (Geyer 2006), mortality from accidents, and lung cancer (Lager and Torssander 2012), whereas occupational class is more strongly related to symptoms such as aching muscles (Miech and Houser 2001), sudden unexpected deaths (Næss et al 2005: 219), and death from injury and poisoning (Erikson and Torssander 2008). These studies speculate that this might be the case because different measures of social position are related to different indicators of health and mortality through distinct mechanisms.

A growing research field on links between social position and health supports this contention, showing that certain health-related resources explain the effects of certain indicators of social position on health and mortality to a greater extent than others. These studies report, for example, that income and other sources of financial means are beneficial for health because they provide access to adequate living conditions in terms of housing, nutrition, and formal and informal health care (Lynch et al. 2000, Lynch 2006, Taylor 2011). In contrast, the effect of occupation was more strongly mediated by working conditions, such as the amount of physical burden, stress at work, the number of working hours per week, and exposure to dangerous conditions (Huisman et al. 2008, Kröger et al. 2016; Warren et al. 2004).

The effect of education on health was long conceptualized as mainly mediated through its association with income and occupation (Ross and Wu 1995). In this regard, the results of Chapter 2, in which I analyzed educational disparities in health before and after controlling for occupational differences and their interactions with age and cohort, suggested that indeed much of the age-related increase in educational health differences in Sweden runs through occupational differences.

Differences in occupations and economic means, however, are only two of the mechanisms behind the relationship between education and health. A recent focus of research considers education also as a source of non-material health resources, such as knowledge, cognitive ability, learned effectiveness, and social support (Mirowsky and Ross 2003, 2005). Studies along these lines have provided evidence that education improves health because it enhances a sense of personal control that encourages a healthy lifestyle and better health management (Mirowsky and Ross 1998, Ross and Mirowsky 2006).

For instance, education is not only negatively related to smoking but also promotes a healthy diet, physical exercise or even precautionary behavior such as wearing seatbelts (Johnson et al. 2016). Higher educated people's advantages in the management of health risks becomes evident when looking at differences in mortality. The larger gaps between higher and lower educated people are found for mortality from diseases for which greater medical progress has been achieved. Research on the "compression of morbidity" debate also found that higher educated people live longer while avoiding a number of diseases that lead to disability (Ferraro 2016). Researchers speculate that this might be due to advantages in knowledge, self-efficacy, and cognitive ability necessary to understand the implications of new health knowledge for individual behaviors and to implement behavioral changes.

Another non-market factor behind the relationship between education and health or mortality is the higher level of social support among higher educated people. For instance, the higher educated are more likely to marry and to stay married. Moreover, their partners are more likely to be higher educated as well (Blossfeld and Timm 2003). Each of these factors is associated with better health (Goldstein and Kenny 2001; McLanahan 2004; Mirowsky and Ross 2003; Pampel et al. 2010; Ross and Mirowsky 1999; Ross and Wu 1995). Social resources residing within marriage and wider social networks buffer harmful effects of stress, help to sustain healthy lifestyles, and prolong lives even after terminal diagnoses (Thoits 1995, 2011; Johnsson et al. 2016).

The beneficial effect of education on health, however, not only results from the advantages it brings in terms of material means, occupations, knowledge, self-efficacy and protective resources from social networks. Studies have further explored the complex nature of the relationship between education and health, asking whether education improves health, whether health improves education, or whether better health and higher educational attainment both result from other advantages established early in life.

For example, high cognitive ability and a strong sense of personal control are beneficial to educational attainment as well as mental health and physical health. It is still unclear to what extent education causally affects such health-relevant resources and to what extent the relationship between education and health results from selection into education. In support of the selection mechanism, Lynch and Hippel (2015) found that better health in adolescence predicted later educational attainment and that a net effect of educational attainment on self-rated health at age 30 was present, though very small. Duke and Macmillan (2016) also support the selection mechanism, finding that general cognitive and non-cognitive skills at age 15 account for a large part if not fully for the relationship between education and health in early adulthood. Other studies found that higher parental education and other advantages in childhood partly explain the relationship between education and health (Ross and Mirowsky 2011; Behrman et al. 2011).

When all of these considerations and empirical findings are taken into account, it is clear that the mechanisms behind the relationship between education and health are highly complex. It was beyond the scope of my dissertation to disentangle these mechanisms. Instead, I used education as a proxy for individuals' early placement in the social hierarchy and a broad stratifier of a wide range of health-related resources including economic means, working conditions, but also family and social capital, knowledge, sense of personal control, cognitive ability, and the probability of experiencing disruptive life events. Because education is highly predictive for the accumulation of all kinds of health-related resources, it is a well-suited measure to test the general prediction of the cumulative (dis)advantage hypothesis. However my results cannot be interpreted with respect to specific mechanisms underlying educational differences in health trajectories. Using additional measures as well as controlling for different measures of socioeconomic position and other determinants of health at different stages of the life course can shed light on the forces shaping educational differences in health trajectories (Erikson and Torssander 2009).

Fourth, my dissertation provides only initial insight into the role of gender both theoretically and empirically. My results have indicated that these differences can be large, and need further investigation, in specific contexts. Further research is needed to understand why cumulative (dis)advantage applies more strongly to women in societies as different as Sweden and the U.S., and why it applies more strongly to men in Germany. One possible explanation is that women in Sweden and in the U.S. less frequently adopt alternative roles as homemakers and mothers, and more often combine them with a role as a full-time worker (Blossfeld and Drobnic 2001; Blossfeld and Hakim 1997). Given that gender roles among lower educated women are more traditional in these countries (Rjiken and Liefbroer 2016), these women might be at a higher risk of double jeopardy as compared to lower educated women in Germany. This argument could also be investigated within the German context, given the long-standing difference between West Germany and East Germany where women are more often full-time employed throughout their working lives.

Another aspect of gender differences that deserves more attention in future research on cumulative (dis)advantage are cross-cohort differences. In the course of the twentieth century, the role of women in the family, in education, and in the labor market has changed dramatically (Blossfeld and Hofmeister 2006; Blossfeld and Drobnic 2001; Blossfeld 1995, 1995a; Blossfeld and Huinink 1992; Drobnic et al. 1999¸ Blossfeld und Jaenichen 1992). In the course of educational expansion, the gender composition of educational and occupational groups has strongly shifted across cohorts. Women became increasingly educated and more likely to enter the upper service class. Looking at the outcome side, a well-known phenomenon is that women report worse levels of health, but live longer than men (Ross et al. 2012). Changes of the gender composition within the educational groups may thus have direct implications for cross-cohort patterns in socioeconomic health gaps. In Chapter 2, I found slight health declines of higher educated people in the most recent cohort (born in the mid-50s and 60s). Changes across cohorts in the gender composition of higher educated Swedes may account for some of these differences. It was beyond the scope of the present dissertation to examine these issues in detail. Future research should shed more light on the changing role of women for socioeconomic disparities in health across lives and cohorts.

Fifth, in a similar vein, more attention should be paid to the mechanisms behind cross-cohort change in life-course patterns of socioeconomic disparities in health. Although cross-cohort differences have received more attention in recent studies, cohort is still primarily seen as a potential confounder of age effects. The mechanisms outlined, for example by the "rising importance" hypothesis, or the pathways of changing gender composition suggested above, are rarely tested empirically. Moreover, the "rising importance" hypothesis has been developed specifically in the U.S. context and cannot be applied to other societies without further consideration. In a recent study, Delaruelle and collegaues (2015) have outlined an alternative hypothesis for societies that undergo a different path of social change. Their "diminishing returns" hypothesis predicts cumulative (dis)advantage of higher education for health to weaken across cohorts. They argue that unlike in the U.S., economic returns to education do not rise or even decline in many developed societies – a phenomenon often referred to as "overeducation" (Groot and Van den Brink 2000; DiStasio et al. 2015). Overeducation, in turn, has been shown to entail harmful effects on health (Bracke et al. 2013).

Moreover, as I have argued above, changes in the composition of socioeconomic groups may differ across countries. For example, gender gaps in education and the labor market have been closing at a different pace in different countries. Another recent development concerns the increasing share of immigrants and their offspring in lower socioeconomic strata (Bender and Seifert 1996; Seifert and Solga 2005). In a number of European societies, the lowest educational tracks currently consist of up to 80% of immigrants from the first and second generation. Future research on socioeconomic disparities in health should consider to what extent the arguments of cumulative (dis)advantage hypothesis apply to these groups, and which implication this has for cross-cohort patterns. For instance, due to the "healthy migrant" effect (Markides and Eschbach 2005), these compositional changes may improve average health levels of lower educated groups.

Finally, I devoted only limited attention to period effects – the third temporal factor that may affect changes of socioeconomic disparities in health. From the theoretical point of view, age and cohort are temporal dimensions that capture changes in socioeconomic disparities in health most adequately. Yet, period effects may still confound age effects, especially in longitudinal data covering large observation periods (Yang and Long 2013). A theory-driven approach to period effects would first identify, which specific periodic effects may confound age or cohort effects, and then attempt to control for such potential periodical confounders. In Chapter 4 on physical health in Germany from 1992 until 2014, there are hardly any periodic influences that fulfill the requirement of a true period effect – namely to affect health independent of age. Based this strict definition, it is difficult to identify period effects on health, given that many population shocks (e.g., disasters, wars, and pandemics, but also positive shocks such as revolutions in medical technology or smoking bans) almost always affect young people in different ways than middle-aged and older people. This does not mean that periodic factors are inconsequential, but it shows that their consequences are most commonly age-graded and therefore more adequately captured by cohort and its interactions with age. This particularly applies to physical health and mortality. For other dimensions of health that are less strongly structured by individual ageing (e.g., mental health and subjective well-being), true period effects might appear.

Looking at the big picture of knowledge on health inequality, my dissertation has added an international comparison of social inequality in health as a life-course and cross-cohort process. As I have shown, not only average health gaps may vary between countries, but also their shape across lives and cohorts. That is, the age at which health inequality emerges, the extent to which it increases throughout adulthood or decreases in old age differ strongly between countries. Moreover, these patterns may or may not change across cohorts.

Consideration of these dynamic characteristics of health inequality not only offers a more complete picture of the phenomenon, but may also help to understand the factors underlying cross-country differences in health inequality. For example, in some contexts, health inequality may emerge early in life, increase only moderately throughout adulthood, and remain constant in old age. In others, these disparities may emerge at an earlier age, increase strongly during adulthood, but decrease in older age when the surviving population is reduced to robust individuals. Although these scenarios differ sharply regarding the extent of health inequality and the forces shaping inequalities, these differences remain largely invisible in cross-sectional analyses that look only at averages across all ages.

Cohort effects may also give insights into the mechanisms behind cross-country differences in historical trends in health inequality. For instance, health inequality may increase over time in two countries, but this trend might be driven by different cohorts. In one country, these might be the younger cohorts (as Chapter 2 has shown in Sweden), while in another country this might apply to each of the cohorts (as Chapter 3 has shown for the U.S.). Knowing which cohorts are driving trends in health inequality allows us to reduce the range of possible explanations to those considering these groups.

Although I analyzed some of these processes, my dissertation is only an initial step in the direction of comparative research on social disparities in health across lives, cohorts, and countries. I have focused on societies that offered sharp contrasts to the U.S. Future research could extend the comparative scope to include more societies. Comparable longitudinal data for further countries are available, for example, in SHARE and ELSA, allowing for the inclusion of other Scandinavian welfare states, Central and Southern European countries, and the United Kingdom. Adding these countries to the analysis will introduce more variation in the contextual factors shaping health inequality across lives and cohorts, such as educational systems, working conditions, income inequality, health care, and social policy.

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